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PLENARY PROCEEDINGS

INTEGRATION OF THE COMPAS FRAMEWORK AND GAME THEORY FOR OPTIMIZING INTERNATIONAL COMPETITIVENESS STRATEGIES

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Abstract. *The article explores the possibility of integrating the COMPAS approach and game theory to optimize international competitiveness strategies. The topicality of the topic is due to the growth of competition on international markets and the limited resources of small open economies, in particular the Republic of Moldova. The purpose of the study is to justify an integrated management model that combines the analytical capabilities of COMPAS and game theory tools for making strategic decisions in an international environment. The study is based on the analysis of statistical data on the foreign economic activity of the Republic of Moldova, indicators of international competitiveness and analytical reports of international organizations for the period 2020–2025. The methodological basis is comparative analysis, institutional analysis and strategic management methods with elements of game modeling. Within the framework of the study, international competition is considered as a strategic interaction of economic agents under conditions of limited information. The results show that the combination of COMPAS and game theory makes it possible to more accurately assess the country's position in international markets and predict the behavior of competitors. The use of an integrated approach makes it possible to increase the validity of the choice of strategies, reduce risks and adapt management decisions to changes in the external environment. The model has special value for the Republic of Moldova, where strategic coordination and rational choice of actions are key conditions for increasing international competitiveness.*

Keywords: *international competitiveness; strategic management; COMPASS; game theory.*

JEL: C72, F12, L10.

Introduction

International competitiveness is a key condition for sustainable development in the face of growing global uncertainty. For small open economies, strategic mistakes are more costly than for large markets. Therefore, we need tools that help make rational choices in a competitive environment. For this purpose, it is advisable to combine framework approaches of strategic analysis and formal models of competitor interaction. Game theory in this context provides a language to describe the conflict of interests, the reactions of rivals and the equilibrium of strategies (Jain, 2023).

Modern literature shows that game theory is actively used to form and explain business competition strategies. It allows you to simulate situations when the result depends not only on your own actions, but also on the behavior of other market participants. This is especially important for international markets where competition is multi-level and contains elements of incomplete information. Practical works confirm that game models can support management decisions in the conditions of competition for markets, resources and sales channels (Lu, 2024). A separate area of research is devoted to optimization game models in the competitive struggle of companies from different countries. Such approaches make it possible to evaluate the consequences of pricing strategies, quality, service and market segment selection. Hierarchical models that describe the "leader-follower" interaction and provide reasons for choosing a strategy in conditions of asymmetry of opportunities and influence are especially useful (Parvasi et al., 2023). At the same time, research shows that game-based approaches are effective not only for price competition, but also for cost management and quality improvement. This is important for international competitiveness, because it is quality and reliability that often

shape access to markets and retention of positions. Game models can be used to optimize quality spending decisions, which strengthens the strategic sustainability of companies (Roman & Dragu, 2023). Much of the current work also considers the integration of game theory with other analytical methods to increase the practical value of models. For example, the combination of game logic with strategic analysis tools makes it possible to evaluate not only the "win" in the short term, but also the long-term competitive position. In this sense, the trend towards the integration of game theory with optimization approaches is important, as can be seen from the review works in the field of financial markets (Ganti & Singhania, 2025).

In the management of supply chains and industrial strategies, there is a growing demand for models that simultaneously take into account digital transformation, risks and strategic interaction of participants. It is here that game approaches make it possible to formalize conflicts of interest between chain participants, as well as the choice between cooperation and competition. Examples of such integrated approaches are shown in research on Industry 4.0 strategies, where game theory is used together with other evaluation methods (Motallebi et al., 2025). At the same time, the theory of games demonstrates wide applicability in areas where the behavior of agents under uncertainty is important, in particular in decision-making on the "demand side" and in complex systems with many participants. This is useful for international competitiveness, because access to markets often depends on the reactions of many parties, and information is incomplete. Systematic reviews emphasize that game models help describe behavioral mechanisms and strategy choices in complex environments (Ji et al., 2024). Research also proves that game models work for constrained optimization problems where competitiveness is determined by regulatory policy frameworks or resource limits. This is important for international strategies, as companies and countries increasingly operate under environmental or carbon constraints. Examples show that game analysis helps evaluate strategic investments and agent behavior in such settings (Suski & Chattopadhyay, 2023). An added value is that game-based approaches are applicable to resilience and risk assessment when balancing criteria weights and making decisions under threats. Although such challenges may be sectoral, their logic carries over to competitive strategies where the risks are systemic. This is confirmed by examples of the use of game methods for assessing system stability and risk management (Lv et al., 2025; Liu et al., 2025). At the same time, for practical strategic management, an important role is played by complex framework approaches that allow assessing the internal capabilities, limitations and positioning of entities on international markets. In this context, the COMPAS model acts as a tool for the systematic assessment of strategic opportunities and weaknesses, which is especially valuable for economies with a high level of external dependence. However, in scientific literature, the issue of COMPAS integration with formalized game theory methods remains insufficiently developed, despite the active use of game models in various fields of management and economics (Roman & Dragu, 2023; Motallebi et al., 2025).

The motivation for choosing the topic is the need to create an integrated approach to the formation of international competitiveness strategies, which combines analytical assessment of capabilities and formalized modeling of strategic interaction. Special attention is paid to the Republic of Moldova as a small open economy, where strategic choice errors have disproportionately high consequences, and the coordination of actions of economic agents is critically important.

The purpose of the study is to justify an integrated management model that combines the COMPAS approach and game theory tools to optimize international competitiveness strategies. The task of the work is to analyze the possibilities of using game models in combination with COMPAS to increase the validity of strategic decisions, reduce risks and adapt to changes in the external environment.

The research uses methods of analysis, comparison and generalization, as well as elements of strategic management and game modeling. The results of modern scientific publications and analytical studies devoted to the application of game theory in business strategies, competitive behavior management and decision optimization are used. The analysis of previous works shows that most studies focus on

certain aspects of game analysis or industry examples, while the integration of framework management models and game theory in the context of international competitiveness remains insufficiently systematized. This determines the scientific novelty and practical significance of this research.

Results

The obtained results reflect the key limitations and opportunities of the international competitiveness of the Republic of Moldova in the context of integration into the EU market. Analysis of modern reports of international organizations shows that the country's competitive position is determined not by one factor, but by a combination of "solid" economic parameters and the quality of management decisions at the level of politics and business. Productivity is the basic structural constraint, as it sets the boundaries for the transition from price competition to differentiation, innovation, and entry into more profitable segments of international markets (World Bank, 2023). In parallel, institutional capacity and predictability of rules shape the economy's ability to scale competitive advantages through stable investment conditions, access to financing, coherence of state support programs, and efficiency of coordination between the state and the private sector (European Commission, 2024). For Moldova, this block is critical, as European integration simultaneously expands market access and increases requirements for compliance, management discipline, and strategic planning, and therefore strengthens the role of management as an "adaptation mechanism" to the external environment (European Commission, 2024).

Separately, the results emphasize the importance of integration into European economic chains as a practical channel for realizing competitiveness. Here, not only the total volume of trade becomes important, but also the structure of exports, the level of concentration in one market, the ability to hold long-term contracts and positioning in value-added chains, where bargaining power, standard requirements and logistical reliability are decisive (Hagemejer & Dąbrowski, 2025). For managerial analysis, this means that competitiveness should be evaluated through indicators that directly affect the choice of strategies: the degree of dependence on the EU market, performance indicators, signs of the "institutional quality" of the SME support policy, as well as the availability of financial and infrastructural resources to strengthen competitive positions (OECD, 2024; European Bank for Reconstruction and Development, 2023). That is why the study summarizes the basic quantitative and structural indicators that can be used as input parameters for the COMPAS framework analysis and subsequent formalized modeling of strategic interaction using game theory. Table 1 presents an extended set of indicators that better "explain" Moldova's international competitiveness from a management standpoint: dependence on the EU market, commodity structure of exports to the EU, scale of bilateral trade, productivity gap, SME readiness for digitalization, and institutional and investment environment.

Table 1. Key indicators of international competitiveness of the Republic of Moldova

Block	Indicator	Value	Period	Management content for strategy
Sales markets and concentration	EU share in Moldova's exports	67% of exports	2024	High "stake on one market": the strategy must be EU-first and compliance-oriented.
Sales markets and concentration	EU-Moldova bilateral trade	EUR 7.6 billion	2024	The size of the "playing field" is already large; it is not "entry" that wins but positioning in value chains.
The structure of exports to the EU	The share of "vegetable products" in Moldova's exports to the EU	28%	2024	Risk of price volatility; strategies for diversification and increasing added value are needed.
The structure of exports to the EU	Other leading groups in exports to the EU	Machines and electrical equipment;	2024	There is a "window" for industrial and processing niches; important contracts, standards, quality engineering.

Block	Indicator	Value	Period	Management content for strategy
		processed food; textiles; metals		
Export dependence (longer series)	Share of exports to the EU-27 in total exports (official series)	58.4%	2022	Shows that the concentration on the EU is a sustainable trend and not a one-time shock.
Productivity and the "power base" of competitiveness	Moldova's labor productivity relative to benchmarks	75% from Mon. Macedonia; 40% from Romania; 20% from Slovenia	assessment in CEM	This is a "structural constraint" in the game: without increasing productivity, the strategy boils down to price and margin.
SMEs and digitalization (possibility of rapid adaptation)	Composite score of SME digitization policies	3.40 (close to the regional average)	SME Policy Index 2024 assessment	Shows "institutional readiness" for digital strategies but does not guarantee their mass in business.
SMEs and digitalization (structure)	The share of SMEs in the ICT sector	5% of SMEs	2021 (last verified point)	There is a core of competencies for service export/IT cooperation; it is important to connect with exporters of goods.
Institutional capabilities	EBRD portfolio in the country	€1.111 million; 57 active projects; 41.8% private share	as of February 2023	There is a resource for "strengthening moves" in the game: funding, infrastructure, management standards.
Policy and coordination with the EU	Coordination of access/integration rules with the EU	Assessment of progress and requirements in the annual report	2024	Fixes the "rules of the game" and their change; it sets the limits and penalties/gains in the model.

Source: summarized by the author based on World Bank (2023), EBRD (2023), OECD (2024), European Commission (2024), Hagemeyer & Dąbrowski (2025).

Table 1 shows that the international competitiveness of the Republic of Moldova is formed in conditions of high concentration in the EU market and at the same time a limited "power base" for the transition to differentiation strategies. Most tellingly, the EU's share of total exports is about two-thirds, which means dependence on one dominant market and its rules, standards and demand cycles (Hagemeyer & Dąbrowski, 2025). In management logic, this reduces the scope for "opportunistic" strategies and increases the price of error, because any change in the regulatory regime or market access requirements quickly translates into lost volumes and margins. That is why the strategy of compliance, stability of contracts and controlled risks becomes critical for companies, and not just the strategy of short-term sales growth. Increasing Moldova's international competitiveness requires a strategy that simultaneously reduces the risk of excessive dependence on one market, increases productivity as the basis of competitive strength, activates the digital and organizational capabilities of SMEs, and uses available investment levers to move to higher added value. It is this set of parameters that is suitable for the further integration of COMPAS and game theory, because it allows us to formalize the constraints, gains and risks of strategic choices in the competitive environment of the EU.

As can be seen from Figure 1, the productivity gap between the Republic of Moldova and the benchmark countries is significant and has a direct managerial interpretation for international competitiveness strategies. On a Moldova = 1 basis, North Macedonia's index is 1.33, Romania's is 2.50, and Slovenia's is 5.00, meaning that even the nearest benchmark has about a third higher productivity, while the gap with the EU's higher-level country is multiple. This means that in a competitive environment, Moldovan companies operate with a lower "efficiency resource" per unit of labor and therefore have less margin for investment in quality, marketing, certification, R&D and

after-sales service. In practical terms, this shifts the structure of competitive strategies towards price competition and shorter contracts, because the cost of differentiation becomes relatively more expensive and less profitable under conditions of limited productivity.

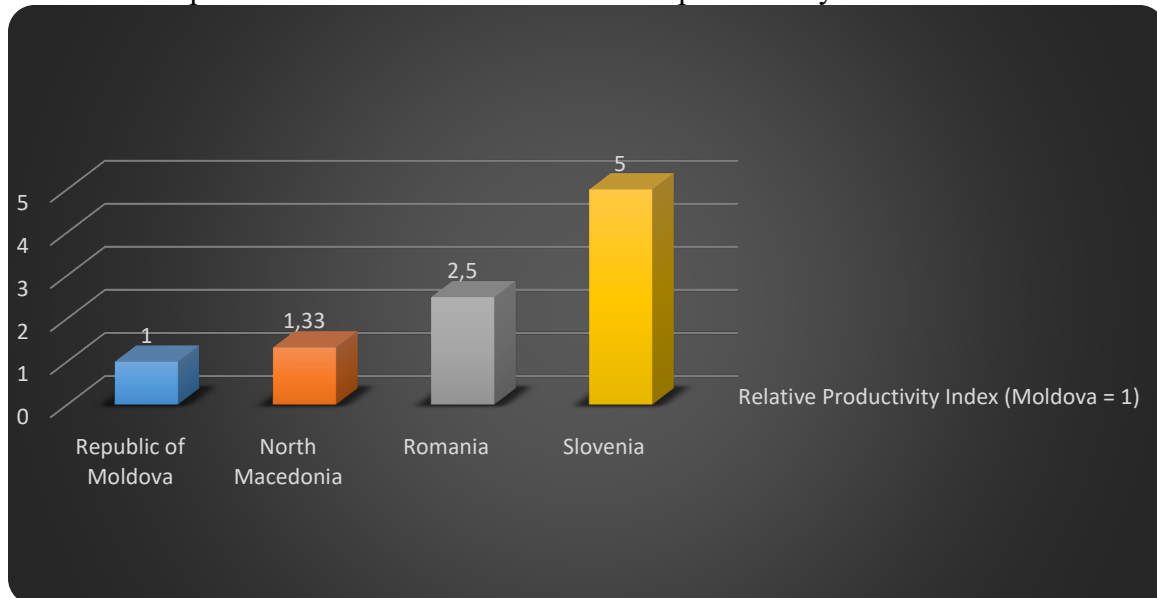


Figure 1. Productivity gap as a limitation of international competitiveness strategies (index: Moldova = 1)

Source: compiled by the author based on data from the World Bank (2023). Moldova Country Economic Memorandum: Boosting Productivity Growth.

In terms of game theory, this changes the “matrix of gains”: strategies of differentiation and long-term positioning have higher initial costs and are more likely to become risky for Moldova, while a low-cost strategy may produce a faster result, but locks the country in segments with lower added value and stronger dependence on the actions of competitors. At the same time, the figure also suggests a managerial conclusion for the integration of COMPAS and game theory: to make "higher-level" strategies rational, it is necessary to change the parameters of the game through the tools of increasing productivity, access to finance and coordination, otherwise the equilibrium of the system will be maintained in low-margin scenarios where Moldova is forced to react rather than set the rules. Summarizing the results, it can be argued that the international competitiveness of the Republic of Moldova in the logic of integration into the EU market is determined by a combination of three interrelated blocks: structural efficiency (productivity), institutional manageability (predictability of rules, coordination and access to financial instruments) and the quality of positioning in European value chains (World Bank, 2023; European Commission, 2024; Hagemeyer & Dąbrowski, 2025). The results show that with a high dependence on the EU market and an existing productivity gap, the country objectively has less room for differentiation and innovation strategies without external reinforcement, and therefore the scenarios of price competition and short-term contracts with increased risk remain dominant (World Bank, 2023). In the management dimension, this means that an effective strategy must be "robust" to uncertainty and competitors' reactions and rely on an integrated system of decisions: reducing concentration risks, increasing productivity as a basis of competitive strength, activating the digital and organizational capabilities of SMEs and using investment levers to move to greater added value (OECD, 2024; European Bank for Reconstruction and Development, 2023). That is why the integration of COMPAS and game theory in this article is not a theoretical construction, but a practical mechanism: COMPAS sets measurable parameters of capabilities and limitations, and game modelling allows you to turn them into a strategy selection rule in a situation of strategic interaction and incomplete information on the EU market.

Conclusions. The article systematizes the results of the analysis of the international competitiveness of the Republic of Moldova in the conditions of integration into the European Union market from the standpoint of the managerial approach. The study showed that the country's competitive position is formed under the influence of a combination of structural economic factors and the quality of management decisions at the level of state policy and business. The basic limitation remains the low level of productivity, which narrows the space for strategies of differentiation, innovation and sustainable entry into segments with high added value and determines the advantage of price competition. It has been established that the high concentration of exports in the EU market simultaneously creates opportunities for access to a large-scale solvent market and increases vulnerability to regulatory changes, logistical failures and increased competition. Under such conditions, institutional coherence, predictability of rules, access to financial instruments and the ability to coordinate actions between the state, financial institutions and enterprises, primarily small and medium-sized ones, become of key importance. The integration of the COMPAS framework and game theory allows us to interpret international competitiveness as a result of strategic interaction under conditions of limited resources and incomplete information. This approach makes it possible to formalize management constraints, assess the risks of different strategies and justify the choice of solutions aimed at increasing productivity, reducing transaction costs and improving positioning in European value-added chains. At the same time, the research has certain limitations associated with the use of aggregated statistical indicators and framework assessments of international organizations, which does not always allow to fully take into account the industry and firm specifics of strategic behavior. Further research should be directed to the construction of applied game models for individual sectors of the economy, the empirical calibration of COMPAS parameters at the level of enterprises, as well as the analysis of strategic coordination scenarios of Moldovan exporters on the EU market. This will contribute to the development of theoretical approaches and the formation of practical tools for increasing international competitiveness in the context of European integration.

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FRIEND-SHORING IN INTERNATIONAL TRADE: RISK REDUCTION STRATEGY OR ECONOMIC FRAGMENTATION?

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Abstract: *This paper examines the structural transformation of global trade under contemporary geopolitical tensions, with a focus on the concept of friend-shoring. It evaluates whether friend-shoring constitutes an effective strategy for reducing risks in global supply chains or contributes to the deepening of geoeconomic fragmentation.*

The paper contributes to the emerging literature on geoeconomic fragmentation by integrating insights from global production network theory with recent empirical and macroeconomic evidence on trade reconfiguration. The analysis is based on a qualitative review of specialized literature and the interpretation of secondary data from academic studies and institutional reports published by organizations such as the IMF, ECB, EBRD, NBER, WTO, and the World Bank.

The results indicate that while friend-shoring can enhance short-term resilience by reducing exposure to geopolitical risks, it generates significant economic costs, including higher intermediate input prices, reduced innovation efficiency, and weaker diffusion of productivity gains. Furthermore, geoeconomic fragmentation leads to uneven welfare losses across regions, with emerging economies facing disproportionate adjustment burdens.

The findings also show that decoupling does not produce a clear separation between trade blocs, but instead reconfigures global interdependencies through intermediary economies and indirect supply chain linkages, limiting the effectiveness of politically driven supply chain restructuring.

The paper argues that friend-shoring represents a transformation of globalization rather than a retreat from it, reshaping the balance between economic efficiency, supply security, and geopolitical resilience.

Key words: *friend-shoring, global value chains, geoeconomic fragmentation, resilience, national security.*

JEL: F13, F14, F23, F52, F60

Introduction

The current economic context is marked by a shift from relatively unrestricted global integration toward a form of organization increasingly shaped by national security interests, a process in which "economic deglobalization may take on a selective nature and apply to different markets, industries and enterprises, as well as to specific goods and services in varying degrees" (Budner et al., 2026, p. 6). Friend-shoring, understood as the redirection of supply networks toward states considered politically allied or compatible, has become a central element of new industrial policies. This trend changes the business environment, as "some MNCs navigate geostrategic globalization by embracing or even catalysing states' geopolitical and geoeconomic objectives" (Schindler & Rolf, 2025, p. 905). The *aim of this paper* is to examine whether friend-shoring is an effective strategy for reducing risks in global supply chains or contributes to the deepening of global economic fragmentation. The paper follows three main lines of analysis: how geopolitical tensions reshape supply chains, the macroeconomic costs of geoeconomic fragmentation (GEF), and the practical limits of decoupling through relevant case studies.

Methodologically, the paper is based on a qualitative analysis of the specialized literature and on the interpretation of secondary data drawn from academic articles, institutional working papers and reports published by organizations such as the International Monetary Fund (IMF), the European Bank for Reconstruction and Development (EBRD), the European Central Bank (ECB), the National

Bureau of Economic Research of the USA (NBER), the World Trade Organization (WTO), and the World Bank. The sources include theoretical studies on global production networks, empirical research, and macroeconomic models estimating the effects of trade fragmentation, decoupling, and the reorientation of investment flows. The research relies on secondary data and findings as already established and validated in the profile literature.

Furthermore, the actual paradigmatic change is examined through the tension between the need to secure critical resources and the risk of weakening the multilateral trade architecture, considering that "a shift may be in the offing from a default bias for efficient global suppliers in a low-tariff world toward more locally or regionally integrated value chains" (Klarin et al., 2024, p. 2266). This approach becomes relevant as economic decisions are no longer shaped only by comparative advantage. Research on global production networks shows that "the decoupling of major economic powers and relentless trade tensions in the international political economy might well trump the competitive logics of global production networks driven by cost minimization, market access, and shareholder pressure" (Yeung, 2021, p. 435).

Proceeding from aforementioned, the supply chain restructuring should therefore not be treated as a purely market-driven process. It reflects a wider shift in which geopolitical criteria increasingly shape the decisions of firms and states. This dynamic matters because "there is a real risk that geopolitical and strategic imperatives will lead to a decoupling and fragmentation of the world economy into hostile political blocs" (Antràs, 2020, p. 37). The paper starts from the *assumption* (hypothesis) that friend-shoring can reduce some immediate supply chain vulnerabilities, while also generating systemic costs through higher prices, lower efficiency, and deeper geoeconomic fragmentation.

Supply chain reconfiguration under geopolitical pressure

The transition toward new production models is driven by a strong perception of national vulnerability. In this context, firms and states are redirecting external relations according to perceived risks, geopolitical constraints, and the need to secure access to essential inputs. This shift goes beyond the traditional logic of economic efficiency, since "friend-shoring has thus become part of a broader shift from market-driven to politically orchestrated production geographies" (Umar & Yang, 2025, p. 197). Supply chain reconfiguration can no longer be understood only as a corporate decision. It results from the interaction between firms, states, and strategic objectives.

The role of the state becomes central in this reconfiguration, even if the state does not fully control the dynamics of global production networks. As the literature shows, "the state is a constitutive part, but not necessarily the central driver, of global production networks" (Yeung, 2021, p.433). In periods of geopolitical uncertainty, the state's capacity to influence firms increases, since "the state can undoubtedly influence these lead firms through specific policy interventions such as strategic industrial policy or trade restrictions"(ibid.) Friend-shoring, therefore, has a broader scope than bilateral trade policy, as it "does not only operate through bilateral trade arrangements to steer the geographic distribution of supply chains to favor geopolitical allies, but proactively aims to shape the whole structure of GPNs by influencing inter-firm and firm-state relations more distinctively" (Kalvelage&Tups, 2024, p. 153).

At the operational management level, these pressures restrict sourcing options and increase attention to political risk. Firms can no longer make decisions only based on costs. They must also assess the stability of relations between the home country and the countries in which parts of the supply chain are located. In this respect, "companies reduce their supply bases in countries where political divergence increases" (Charpin&Cousineau, 2025, p. 1008). This tendency shows that international logistics is increasingly shaped by security criteria, with efficiency often subordinated to geopolitical traceability.

This form of risk-averse governance leads to more redundant supply chains, but not necessarily to more transparent ones. In large global networks, mapping all dependencies becomes increasingly difficult because "with such a large network, it is easy to see how supply chain visibility can turn to supply chain opaqueness" (Baldwin & Freeman, 2022, p. 11). This lack of transparency explains why

simply changing direct suppliers does not guarantee risk reduction. Exposure may persist through sub-suppliers, intermediate inputs, or indirect trade routes.

In strategic resources, friend-shoring is presented as a way to make supply more predictable. This is especially relevant for sectors dependent on critical raw materials, as "ensuring a reliable supply chain through friend-shoring can offer industries like tech and green energy more predictable access to critical minerals" (Vivoda& Matthews, 2024, p. 468). This predictability involves additional costs, since supplier reconfiguration, monitoring of new partners, and compliance with political or ESG standards can make sourcing more difficult.

Politically based resilience still faces logistical and informational obstacles. States can support supply chain reorganization through industrial policies, trade restrictions, or investment incentives, but risks are not eliminated, they are redistributed. The loss of access to high-performing suppliers may also affect firms' capacity to innovate, since "each country whose firms lose access to the most productive suppliers face higher cumulative diffusion inefficiencies" (Góes&Bekkers, 2022, p. 28). Friend-shoring can reduce some visible vulnerabilities, but it can also create other costs by limiting access to technology, knowledge, and higher-quality inputs.

Overall, supply chain reconfiguration under geopolitical pressure shows that economic security has become a central criterion in the organization of global production. Firms have to accept higher costs, while states intervene more directly in the orientation of trade and investment flows. This reorganization does not eliminate the structural risks of globalization. It turns them into dependencies that are more complex, costlier, and sometimes harder to observe.

Geeconomic fragmentation and its impact on global welfare

Although friend-shoring policies are promoted as mechanisms for risk reduction, the profile research shows that geeconomic fragmentation involves high systemic costs. In this respect, "a shift to near- or friend-shoring could decrease local producers' vulnerability to geopolitical developments and global shocks, but would entail substantial costs and significant disruptions" (Aiyar et al., 2023, p. 13). This suggests that economic security is obtained through a direct "trade-off" with the efficiency of the global system.

The impact of these changes becomes more pronounced in economies that depend heavily on global integration, where restrictions on trade flows affect production and long-term growth. The analysis shows that "dynamic losses far outsize static losses" (Góes&Bekkers, 2022, p. 27), suggesting that the negative effects are not limited to initial shocks. They grow over time through weaker access to technology and more productive suppliers.

At the level of international trade, the fragmentation is not compensated by the reallocation of flows between allied states. Economic models indicate that "in a scenario of trade fragmentation, losses in trade flows between blocs would not be fully compensated by the diversion of trade within blocks, causing net trade losses" (Attinasi et al., 2023, p. 2). This structural limitation reflects the rigidity of global supply chains, especially for intermediate goods. Besides that, the disruptions in supply chains affect both production and trade flows. The analysis of the European Central Bank finds that "supply chain disruptions have a negative impact on global industrial production and trade, and a positive impact on inflation" (Attinasi et al., 2021, p. 5). This supports the view that supply chain reconfiguration can create macroeconomic costs through weaker trade activity and higher prices.

The costs are also confirmed by simulations of supply chain reorganization, which show that fragmentation can generate more severe effects than other recent economic shocks. In this context, "for all of them, though, losses from zero-Covid policy in China are lower than the losses under the friend-shoring scenario using iceberg trade costs" (Javorcik et al., 2023, p. 18). This comparison highlights the structural and persistent character of the losses generated by the geopolitical reorganization of trade.

The negative effects of fragmentation are global, although their intensity differs across regions. The results show that "as before, the GEF produces negative impacts across all regions with Latin

American and the Caribbean showing the smallest negative impact and Emerging Market Europe showing the biggest losses" (Bolhuis et al., 2023, p. 17-18). No economic area is fully insulated from the consequences of these changes.

In practice, decoupling remains incomplete, and global supply chains continue to be connected through intermediary economies. Thus, "there is a robust and economically sizable association between the increase of Chinese presence in a country, measured either through exports or announced greenfield investment, and the increase in trade outward linkages of that country with the United States" (Gopinath et al., 2024, p. 13). This dynamic suggests that fragmentation does not remove dependencies. It reshapes them into more complex forms.

As far as the strategic resources are concerned, diversification efforts imply additional costs for firms and states. Vivoda and Matthews note that "initial diversification might elevate costs, especially if new supply chains uphold stricter ESG standards" (Vivoda & Matthews, 2024, p. 468). Securing supply creates further pressure on production costs and final prices.

Fragmentation also affects capital flows, limiting the role of international investment in supporting economic growth. In this respect, "for both foreign direct investment and portfolio investment flows, it is evident that the importance of these flows relative to world GDP peaked right before the Great Recession and, by 2018, they were nowhere near to recovering from those peak levels" (Antràs, 2020, p. 9). This development indicates a trend of retreating in financial globalization, which may amplify the effects of trade fragmentation.

Overall, the specialized literature converges on the idea that geoeconomic fragmentation is not just a risk reduction strategy, but a structural transformation of the global economy, characterized by high costs, reduced efficiency and unequal redistribution of the benefits of globalization.

Market dynamics and the limits of decoupling

The application of decoupling strategies by major economic powers shows the gap between the political goal of securing supply and the reality of global markets. In the case of the United States, the shift has not produced a clear break from global supply chains, but rather a partial relocation of suppliers, since "a significant reallocation in global supply chains has been set in motion, most notably along the dimension of sourcing partner countries" (Alfaro & Chor, 2023, p. 14). This reorientation should be interpreted in a broader context in which geopolitical risk affects economic decisions, as "a shock to geopolitical risk induces persistent declines in investment, employment, and stock prices" (Caldara & Iacoviello, 2022, p. 1196).

The effects are also visible in USA trade in strategic products. In the analysis of US imports, "China's share fell 5.3 percentage points" (Freund et al., 2023, p. 5), which shows a change in direct suppliers. Yet this decline does not automatically mean greater productive autonomy, since "there is growing evidence that direct links between the U.S. and China are simply being replaced by indirect links" (Gopinath et al., 2024, p. 12). In this way, decoupling changes the form of dependence, not necessarily its economic substance.

This limit is explained by the nature of global production networks. The global economy consists of "complex and dynamic economic networks made up of inter-firm and intra-firm relationships" (Gereffi, 2013, p. 2), which makes a rapid separation of trade blocs difficult. In the case of routes through Vietnam and Mexico, this complexity becomes clear, since "the indirect supply chain links of the U.S. to China remain intact" (Alfaro & Chor, 2023, p. 26). On some dimensions, these links have even intensified, showing that friend-shoring can change the commercial label of a product without removing dependence on Chinese inputs.

Trade policies used to support decoupling also change the price mechanism. In the case of the U.S.-China trade war, "tariffs could affect export prices through three channels: foreign tariffs could dampen foreign demand, while domestic tariffs could increase imported input costs or reallocate expenditures to domestic goods" (Fajgelbaum & Khandelwal, 2021, p. 15). Decoupling involves more than changing suppliers. It also transfers additional costs to firms and consumers. At the same time,

reorientation toward partners considered friendly does not guarantee general resilience. Such a strategy may work for certain political risks, but it can weaken the system's ability to absorb other shocks, since "decoupling from unfriendly nations may increase resilience to specific geopolitical shocks, but decrease resilience to other shocks unrelated to politics" (Goldberg & Reed, 2023, p. 30). This explains why friend-shoring produces selective security, rather than full supply chain stability. In this context, the costs appear in various dimensions. They come up through the macroeconomic effects of supply chain disruptions: "world trade would have been around 2.7% higher cumulatively in the absence of supply chain shocks, while global industrial production would have been around 1.4% higher" (Attinasi et al., 2021, p. 5). The costs also appear in models of trade fragmentation. It is shown that "welfare losses can be significant, although they are quite heterogeneous across economies" (Attinasi et al., 2023, p. 4). For multinational firms, this heterogeneity is amplified by geopolitical positioning strategies, since "some MNCs seek to avoid geopolitical alignment and maintain access to both the U.S. and China" (Schindler & Rolf, 2025, p. 899). This behavior confirms that firms do not automatically follow the political lines drawn by states. They seek to preserve access to markets, capital, and technology.

Comparisons with other economic shocks suggest that friend-shoring can generate higher costs because it requires complex and long-term adjustments in supply chains. At the regional level, the effects are uneven, but generally negative. Even states that attract new trade flows may remain exposed to losses generated by fragmentation.

The limits of decoupling are also reinforced by the lack of transparency in supply chains. In large global networks, firms may find it difficult to identify all real exposures, especially when they appear at the level of sub-suppliers or intermediate components. This problem is relevant for firms seeking to reduce exposure to China, since risks may remain hidden in secondary links of production. Even when the direct link is interrupted, trade relations do not disappear. They are reconfigured through indirect channels, alongside the growing presence of intermediary actors and the strengthening of external trade linkages.

For smaller economies, these transformations create a difficult position. They may benefit from the relocation of some flows, but they do not have the capacity to set the rules of the trade game. Against this background, the issue is "how the persistence of trade wars would impact the future of globalisation" (Antràs, 2020, p. 37). At the same time, recent U.S. policies show that firms are looking for alternative suppliers without fully abandoning the existing production infrastructure. In doing so, the "countries that were more deeply engaged in Chinese supply chains experienced the most rapid export growth to the USA" (Freund et al., 2023, p. 4).

Overall, the aforementioned examples show that decoupling does not produce a clean break between economic blocs. It generates intermediary routes, adjustment costs, and dependencies that are harder to trace. Friend-shoring and nearshoring can reduce some visible risks, but they do not remove the structural interdependence of global markets. The result is a more fragmented, costlier and less transparent economy, in which supply security is achieved through efficiency losses and the transfer of risks to other links in the chain.

Conclusions

This analysis shows that contemporary strategies for reorganizing global supply chains, especially those associated with friend-shoring, are better understood as an adaptation to geopolitical risks rather than a structural solution for eliminating vulnerabilities. Although these policies are designed to increase economic security, they generate significant side effects, including higher costs, market fragmentation, and lower global efficiency.

At the macroeconomic level, geoeconomic fragmentation leads to welfare losses and an uneven distribution of effects across regions, with stronger pressure on smaller economies and countries that depend more heavily on international trade. Restrictions on trade and financial flows also reduce the diffusion of technology and slow innovation, which weakens long-term growth prospects.

At the microeconomic level, firms operate in an environment marked by greater uncertainty, where decisions are no longer guided only by economic criteria but also by geopolitical constraints. This leads to supply chain restructuring, higher redundancy, and the acceptance of greater costs in exchange for perceived resilience. The analyzed examples show that this resilience remains partial, since dependencies do not disappear. They are reconfigured through intermediaries and indirect relationships.

In this context, economic decoupling does not create a clear separation between blocs. It produces a complex rearrangement of global interdependencies. Supply chains become more opaque, more fragmented, and harder to manage, which complicates both corporate strategies and public policy.

Friend-shoring and related strategies should therefore be understood as a transformation of globalization, not as a withdrawal from it. The global economy remains deeply interconnected, but this interconnection is increasingly mediated by political considerations, reshaping the balance between efficiency, security, and resilience.

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Section 1:
**ECONOMY AND INTERNATIONAL ECONOMIC
RELATIONS**

HARNESSING THE INACTIVE POPULATION TO ADDRESS LABOUR SHORTAGES IN THE REPUBLIC OF MOLDOVA

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Abstract: *Labour shortages have emerged as a structural constraint to economic development in the Republic of Moldova, driven by demographic decline, sustained outmigration, and persistently low labour force participation. Despite the presence of a sizeable economically inactive population, the extent to which inactivity can be harnessed to alleviate labour shortages remains insufficiently quantified. This study addresses this gap by proposing a transparent, scenario-based framework to assess the realistic activation potential of the inactive population under prevailing structural constraints.*

Using official data from the National Bureau of Statistics for the third quarter of 2025, the inactive population is decomposed into three mutually exclusive groups: structurally unavailable, conditionally activatable, and potentially activatable. Based on this classification, conservative activation scenarios are constructed to estimate upper ceilings for feasible labour supply mobilisation. The results indicate that more than half of the inactive population is structurally unavailable for activation in the short to medium term, primarily due to ageing and migration-related constraints. The realistic activation margin is concentrated in a limited subset of conditionally and potentially activatable individuals, such as caregivers, students, and discouraged workers.

Scenario-based estimates suggest that, even under favourable policy conditions, activation could mobilise at most between 136 and 232 thousand persons, implying that labour market activation alone cannot fully offset labour shortages. These findings underscore the need to treat activation as a complementary policy tool rather than a standalone solution. The study concludes that effective responses to labour shortages in Moldova require a coordinated strategy combining selective activation of inactive populations, improvements in job quality and wage-setting mechanisms, productivity-enhancing investments, and targeted labour migration policies.

Key words: *Labour shortages, economic inactivity, labour force participation, labour market activation, activation potential*

JEL: J21, J23, J61, J68, O15

Introduction

The demographic decline and the outmigration are among the major causes of labour shortage in the Rep. of Moldova. If previously one way to attract foreign investors was by owing them with cheap, and plenty labour force, nowadays, Moldova is facing a labour shortage and albeit the one that exists is expensive. Business associations and think tanks [11] have repeatedly signalled to the Government and the community as a whole the issue of labour shortage [1] including in the context of the implementation of the 2024-2027 Reform Agenda under the EU Growth Plan [6]. Some businesses see as a solution employing labour force from abroad [5]. Even though hiring labour force is a solution to address labour shortage in the areas Moldova lacks skills and population willing to participate, the data shows that there is still inactive population in the labour market in the country that could be attracted into the activity. Thus the question to be addressed in this research is how far and in what way can the inactive population be harnessed to address labour shortages in the Republic of Moldova? With regard to the labour shortage definition, Barnow, Trutko and Piatak see it as „an occupational labour shortage as a sustained market disequilibrium between supply and demand in which the quantity of workers demanded exceeds the supply available and willing to work at the prevailing wage and working conditions at a particular place and point in time” [2]. However, according to

Handel (2024), to determine whether a labour shortage exists, it is necessary to distinguish between normal labour market tightness and true shortage conditions. Moreover, many discussions of labour shortages focus on specific occupations, which would require detailed data on job vacancies by occupation, data that are rarely available. As a result, most assessments of labour shortages in practice are based on general job vacancy data rather than occupation-specific evidence [8]. There is also a question on how to measure the labour shortage. Some measure it by "job openings that could not be filled at all" [10]. According to the authors there is no clear boundary between normal labour market tightness and a true shortage. Because reliable vacancy data by occupation are largely unavailable, shortages cannot be identified using a single quantitative indicator and are instead inferred from a combination of signals, especially employer responses. In practice, evidence of labour shortages relies heavily on employer behaviour such as intensified recruitment, wage increases, overtime use, or relaxed hiring standards rather than on vacancy statistics alone [2].

Literature review.

The literature on labour shortages in the Republic of Moldova portrays it as a structural phenomenon, driven by demographic decline, sustained emigration, and weak labour market participation, rather than by short-term demand fluctuations. A central strand of research highlights the role of poor job quality and weak wage-setting mechanisms in sustaining inactivity and labour outflows. Vaculovschi (2024) shows that persistently low wages especially in agriculture and the public sector, have eroded the motivational and reproductive functions of employment, generating a large group of working poor and encouraging labour force withdrawal, emigration, and high turnover. As a result, labour shortages persist despite the presence of inactive or underutilised labour, suggesting that activation policies are ineffective in the absence of adequate wages and working conditions [19].

Several studies emphasise that labour shortages in Moldova coexist with low employment and participation rates, pointing to underutilised domestic labour resources. Savelieva and Zaharov (2021) argue that structural imbalances stem not only from labour shortages but also from high inactivity among women, older workers, and low-skilled individuals, exacerbated by demographic decline, migration, and insufficient job quality. Existing social policies, they argue, have only partially succeeded in activating inactive persons due to weak incentives and limited access to training [15]. In a follow-up study, Savelieva and Zaharov (2022) demonstrate that despite very low unemployment, nearly 60% of the working-age population is economically inactive, with over 90% neither seeking nor available for work. Inactivity is concentrated among pensioners, homemakers, and students, while return migration represents a diminishing and uncertain labour reserve, underscoring the structural limits of mobilisation. The authors conclude that labour shortages can only be addressed through a combination of activation measures and improvements in job quality, wage-setting, and labour market institutions [16]. A related body of work conceptualises labour shortages as a manifestation of labour force underutilisation rather than a simple lack of workers. Using ILO labour underutilisation indicators (LU1–LU4), Sârbu and Cimpoieş (2020) show that although unemployment in Moldova is low, overall labour underutilisation exceeds 11%, revealing substantial hidden reserves among the underemployed and economically inactive. Inactivity and underemployment are driven by ageing, migration, low wages, and precarious employment, particularly in rural areas. Importantly, many employed individuals express willingness to work more hours or change jobs if wages improved, indicating that labour shortages coexist with unused labour capacity due to weak work incentives. This perspective reinforces the need to distinguish between different inactive groups based on their constraints and activation potential [17]. Migration-focused studies further stress the structural nature of labour shortages. Țugui (2024) situates Moldova's labour market imbalances within the context of European integration and intra-European labour mobility, showing that persistent negative net migration has reduced labour supply and contributed to the lowest employment rate in Europe. Employer surveys indicate that shortages are driven not only by emigration but also by low wage attractiveness, skills mismatches, and limited applicant availability. The author argues for a

reorientation of labour market policy toward participation and reintegration targeting women, youth, older workers, return migrants, and residents of the left bank of the Dniester while complementing these measures with selective labour immigration [18]. Bîrcă (2023), based on a survey of 350 enterprises, finds that 88% of organisations report labour shortages, driven by both quantitative deficits and qualitative mismatches. Key barriers to recruitment include low wages, weak incentive systems, and limited training opportunities, particularly for SMEs. Firms respond by intensifying recruitment and adjusting hiring practices, while calling for public interventions aimed at training, wage support, and reintegration of underqualified workers. This evidence highlights the interaction between labour demand, job quality, and the limited responsiveness of inactive populations [3].

Several studies underline that the scope for activation is further constrained by demographic ageing and sector-specific conditions. Gagauz, Tabac, and Pahomii (2023) demonstrate that over 90% of Moldova's population decline over the last three decades is due to emigration, predominantly among young and working-age cohorts. This has accelerated ageing and reduced the pool of economically active and potentially activatable persons, while projections to 2040 indicate continued population decline and a rising share of individuals aged 50+, regardless of short-term activation measures [7]. Heghea (2020) provides micro-level evidence on elderly workers, showing that while some pensioners remain attached to employment, their activation potential is highly stratified by education, health, and residence, and constrained by poor job quality, age discrimination, and weak institutional support. Finally, a growing strand of literature highlights technological adaptation as a complementary response to labour shortages [9]. Popa (2024) argues that in industry, demographic decline and migration have structurally constrained labour supply, while productivity gains have been driven mainly by price effects rather than real efficiency improvements. The study suggests that digitalisation and Industry 4.0 technologies can help offset labour shortages but cannot substitute for labour market activation [14]. Similarly, Negai et al. (2025) show that in agriculture, automation and precision technologies are necessary to compensate for chronic labour scarcity and ageing rural populations. Both studies emphasise that technological solutions must complement, rather than replace, selective activation of available labour reserves [12].

Thus, the literature converges on the view that labour shortages in Moldova are structural, coexist with high inactivity, and cannot be resolved solely through labour immigration or short-term activation measures. However, while existing studies document inactivity, migration, and job quality constraints, they rarely provide an explicit framework to distinguish between inactive groups with different degrees of activation potential or to quantify realistic mobilisation ceilings. This gap motivates the present study's scenario-based approach, which systematically differentiates between structurally unavailable, conditionally activatable, and potentially activatable inactive populations using official aggregate data.

Despite extensive discussion of labour shortages and migration in the Republic of Moldova, existing research has largely treated labour shortages and economic inactivity as separate phenomena, without systematically assessing how much of the inactive population can realistically be mobilised under structural constraints. Most studies rely on descriptive indicators or employer surveys, while few offer an explicit framework for distinguishing between structurally unavailable, conditionally activatable, and potentially activatable inactive groups.

This study contributes by introducing a transparent, scenario-based framework to estimate activation potential in data-constrained contexts, identifying upper ceilings for feasible labour mobilisation using official aggregate statistics, and reframing labour shortages as a problem of limited and unevenly distributed activation capacity rather than a simple shortage of workers. Future research should extend this approach using microdata to estimate activation probabilities and assess regional, sectoral, and policy-specific variation over time.

Analysis and model

The descriptive evidence provided by the National Bureau of Statistics [4] for the third quarter of 2025 on the economically inactive population, indicates that labour market inactivity in the Republic of Moldova is structural rather than cyclical. The inactivity rate of the population aged 15 and over reaches 55.1%, while even among the core working-age population (20–64 years) inactivity remains exceptionally high at 39.2%, a level that substantially exceeds European benchmarks and cannot be explained by short-term economic fluctuations. This persistence points to a long-term failure of labour market participation mechanisms rather than temporary fluctuations related to business cycles. Moreover, the composition of the inactive population further constrains the scope for rapid activation. Nearly 44.6% of inactive individuals are pensioners, whose labour market reintegration is limited by age, health, and institutional factors. Another 13.8% consist of students, whose primary activity is education and whose labour market participation is typically partial and transitional. A further 11.6% are persons engaged in unpaid family and care responsibilities, predominantly women, reflecting structural care constraints rather than weak labour demand. Finally, 11.3% of inactive persons are already working abroad or intend to migrate, representing a group largely disconnected from the domestic labour market. Taken together, these figures indicate that the potential for activating the inactive population to address labour shortages is rather limited, as a substantial share of inactivity reflects demographic, social, and migration-related constraints that cannot be rapidly or fully offset through standard activation policies. The remaining share of inactive persons (18.7%) consists of heterogeneous categories that include discouraged workers, persons with health limitations below retirement age, and other non-classified inactive individuals, representing the primary, though limited, reserve for labour market activation. In Table 1 below the activation potential is provided for each of the groups.

Table 1. Structure of the Economically Inactive Population and Activation Potential in the Republic of Moldova

Group	Share	Activation potential
Pensioners	44.6%	Low (selective only)
Students	13.8%	Medium (part-time, transition)
Caregivers	11.6%	Medium–High (conditional)
Abroad/planning migration	11.3%	Low–Medium (highly conditional, contingent upon right policies to attract diaspora and to create opportunities at home)
Other inactive population	18.7%	Highest, though limited

Source: Developed by the author based on the data from the National Bureau of Statistics

Following OECD (2025) [13], economically inactive populations are heterogeneous and subject to distinctly different structural constraints, implying that only a limited share can be realistically mobilized. Building on this categorization-based approach, this paper extends the analysis by introducing conservative, scenario-based activation ceilings for conditionally and potentially activatable groups

Therefore, after the description of the groups as provided by the National Bureau of Statistics and after assessing the activation potential, as a next step it is worth splitting the inactive population into three mutually exclusive groups.

We can formally represent this as follows:

$$\text{Inactive} = S + C + P \quad)$$

Where:

- S (Structurally unavailable) → cannot be activated in the short/medium term

- C (Conditionally activatable) → activation possible only if constraints are relaxed
- P (Potentially activatable) → highest realistic activation potential

Next, the inactive categories reported in Table 1 are mapped into the three mutually exclusive groups S, C, and P.

1. In the Structurally unavailable (S) group the categories that are facing hard constraints will be included i.e Pensioners → 44.6% and Abroad / planning migration → 11.3%

$$S=44.6+11.3=55.9\%$$

2. In the Conditionally activatable (C) group where the activation depends on specific policies the following will be included: Students → 13.8% and Caregivers → 11.6%

$$C=13.8+11.6=25.4\%$$

3. Potentially activatable (P) which is the residual category with highest activation margin the Other inactive population → 18.7% will be included

$$P=18.7\%$$

Thus the category, definition and share is presented in Table 2:

Table 2. Decomposition of the Economically Inactive Population by Activation Potential

Category	Definition	Share (%)
Structurally unavailable (S)	Pensioners + abroad/planning migration	55.9
Conditionally activatable (C)	Students + caregivers	25.4
Potentially activatable (P)	Other inactive population	18.7
Total inactive population		100.0

Source: Developed by the author

Next to illustrate feasible mobilization ranges, we define a set of low, medium, and high scenarios using assumed activation rates:

- 0% activation from S (For a conservative short-term scenario, S is treated as non-activatable, although selective activation, for example part-time work among pensioners and return migration is possible)
- 20–40% activation from C
- 40–60% activation from P

It should be noted that, because the total refers to the inactive population aged 15 and over, the resulting activation counts represent an upper ceiling rather than expected outcomes. To illustrate feasible mobilization ranges, we calculate a range for the upper-ceiling activation share implied by the assumed activation rates:

$$\text{Potential activation share} = (0 \times 55.9) + (0.2 - 0.4 \times 25.4) + (0.4 - 0.6 \times 18.7) \quad (2)$$

For reference, given a total inactive population (15+) of 1,086.9 thousand persons, the corresponding population sizes of each group are:

- Structurally unavailable (S) ≈ 607.9 thousand persons
- Conditionally activatable (C) ≈ 276.1 thousand persons
- Potentially activatable (P) ≈ 202.9 thousand persons

Applying the assumed activation rates to groups C and P yields an upper-bound mobilisable labour supply ranging from approximately 136.5 thousand persons (low scenario: 20% of C and 40% of P) to 232.4 thousand persons (high scenario: 40% of C and 60% of P).

Conclusions

1. Labour shortages in the Republic of Moldova are structural rather than cyclical, driven by demographic decline, sustained outmigration, and persistently low labour force participation, rather than by short-term fluctuations in labour demand. The coexistence of high inactivity and labour

shortages reflects deep-seated participation failures and weak work incentives rather than insufficient job creation alone.

2. The potential for mobilising the inactive population to alleviate labour shortages is inherently bounded. More than half of the inactive population (55.9%) is structurally unavailable for activation in the short to medium term, as it consists primarily of pensioners and persons already working or planning to work abroad. These groups face hard demographic, health, and migration-related constraints that limit their responsiveness to standard activation policies.

3. The realistic activation margin is concentrated in a limited subset of the inactive population. Conditionally activatable groups, i.e. students and caregivers, account for 25.4% of inactivity and can be mobilised only if key constraints such as care responsibilities, rigid working arrangements, and weak school-to-work transitions are addressed. The remaining 18.7%, consisting of heterogeneous inactive persons, represents the primary but still limited domestic labour reserve.

4. Scenario-based estimates indicate that even under favourable conditions, activation can only partially offset labour shortages. The upper-ceiling mobilisation range of approximately 136–232 thousand persons confirms that activation policies, while necessary, are insufficient on their own to fully compensate for demographic decline and migration-driven labour deficits.

Therefore, harnessing the inactive population should be viewed as a complementary rather than a standalone solution, requiring coordination with wage policy reforms, job quality improvements, productivity-enhancing investments, and selective labour immigration. Activation should be prioritized where it is most feasible. Policy efforts should focus on conditionally and potentially activatable groups, particularly caregivers, discouraged workers, and inactive persons of working age with residual work capacity, rather than dispersing resources across structurally unavailable groups. To make activation effective, the job quality should be improved. Raising the minimum wage in line with living costs, reducing informal employment, and strengthening wage-setting mechanisms are essential to ensure that re-entry into employment is financially viable and sustainable. The activation should be complemented with productivity-enhancing and migration policies. Given the limited activation ceiling, labour market policy should be coordinated with investments in automation and digitalisation, as well as selective, skills-based labour immigration and targeted return-migration incentives.

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DIGITAL INNOVATION IN CUSTOMS PROCESSES: DRIVING THE REPUBLIC OF MOLDOVA'S INTEGRATION INTO THE EU SINGLE MARKET

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Abstract: *The digitalization of customs administration represents an essential element of the institutional and economic convergence process of the Republic of Moldova with the European Union, serving as a central pillar in its accession path. In the context of the candidate country status and the implementation of rigorous obligations assumed through the Association Agreement and the DCFTA, the modernization of the digital customs infrastructure contributes directly to the reduction of non-tariff barriers, the efficiency of external trade flows, and the increase of national economic competitiveness. This paper analyzes the strategic implementation of key state-of-the-art information systems – NCTS 5, AES, AIS, EES, BQS, and e-AEO – and highlights the technical mechanisms through which they facilitate functional integration into the European Single Market. The research methodology is based on a mixed approach, combining the documentary analysis of national digital transformation strategies with the evaluation of performance indicators provided by the Customs Service and reports from international organizations. The analyzed data reflect the impact of automation on customs clearance times and transactional costs for economic operators. The results of the study demonstrate that the digitalization of customs processes constitutes not just a simple administrative reform, but a strategic instrument for structural integration, capable of eliminating information asymmetries and ensuring the traceability of goods in real-time. The conclusions indicate that the interoperability of Moldovan information systems with the digital architecture of the European Union is the fundamental premise for transforming borders into efficient logistical hubs, accelerating economic convergence and strengthening the Republic of Moldova's position within European value chains.*

Keywords: *Customs Digitalization, European Single Market, Trade Facilitation, Republic of Moldova, Customs Processes*

JEL: F13; F15; O24; O33; L81

Introduction

The integration of the Republic of Moldova into the European Union entails a complex process of legislative, institutional, and technological harmonization. The customs domain occupies a central position in this process, as it serves as the primary interface between the national economy and the European economic area. Given that approximately 70% of Moldovan exports are directed toward European Union member states, the efficiency of customs processes directly influences external competitiveness and the capacity for integration into European value chains.

Although preferential access to the community market is guaranteed through the DCFTA, administrative and procedural barriers can generate additional costs for economic operators. Border wait times, paper-based documentation, the lack of digital interoperability, and redundant controls can diminish the acquired tariff advantages. In this context, the digitalization of customs processes becomes an essential tool for reducing transaction costs and achieving functional integration into the Single Market.

The research problem consists of evaluating the extent to which the digital modernization of customs administration effectively contributes to the integration of the Republic of Moldova into the European economic space. The research hypothesis posits that the implementation of information systems

interoperable with the European Union's digital infrastructure reduces non-tariff barriers and strengthens institutional convergence.

Research Problem

The current (or pre-digital) framework of customs operations in the Republic of Moldova has been characterized by a series of structural dysfunctions that acted as genuine non-tariff barriers to trade. These negative aspects can be synthesized through the following analytical axes:

1. Procedural Redundancy and the "Parallel Documentation" Phenomenon The reliance on physical, paper-based information flows has generated an inefficient administrative architecture. Manual processing of customs declarations entails a high rate of human error and data redundancy, as economic operators are frequently compelled to provide identical information to multiple regulatory authorities.

2. Information Asymmetry and Lack of Predictability The absence of interoperable digital systems has perpetuated a state of information asymmetry between customs authorities and the private sector. Without real-time monitoring capabilities, clearance processes have become unpredictable, generating significant opportunity costs for stakeholders.

3. Technical Incompatibility with the Community Space (The Technological Gap) Technological decoupling has forced border crossing points to function as logistical bottlenecks. At these points, procedures must be re-initiated from scratch upon entry into the EU common space, effectively neutralizing the advantages of geographical proximity.

4. Integrity Vulnerabilities and Compliance Risks Analog systems are, by definition, opaque. Frequent physical interaction between the declarant and the customs official, coupled with the lack of automated risk analysis mechanisms, has facilitated structural vulnerabilities regarding integrity and professional ethics.

Theoretical Framework of Customs Digitalization and Economic Integration

In economic literature, trade efficiency is frequently analyzed through the lens of Transaction Cost Theory. According to this approach, costs associated with administrative processes, information verification, and regulatory compliance can significantly influence the volume and structure of international trade. Within the customs domain, these costs are generated by complex bureaucratic procedures, repetitive controls, lack of document standardization, and procedural uncertainty.

The digitalization of public administration has the potential to mitigate these costs by automating information flows and standardizing interactions between the authority and the business environment. According to World Bank reports (2024), electronic filing systems and automated risk analysis reduce processing times and increase transparency, thereby contributing to an improved investment climate. Integration into the European Single Market, however, implies more than mere administrative efficiency. It involves the elimination of non-tariff barriers and the harmonization of technical and procedural standards. In the absence of digital interoperability, procedural discrepancies can function as indirect barriers, adversely affecting the competitiveness of exporters. Thus, technological convergence becomes a prerequisite for economic convergence.

Currently, the digital infrastructure of the Customs Service (CS) lacks the necessary integration capacity with European information systems. It is not yet integrated with transit or tariff management resources, which hampers the real-time movement and verification of documents. Many digital counterparts do not exist in Moldova, and the incomplete harmonization of the Moldovan regulatory framework with the EU Customs Code hinders full digitalization and legal compliance.



Figure 1. Digital Transformation of Customs

Source: Developed by the author

The program will modernize the customs infrastructure to ensure the rapid and secure exchange of data with EU customs authorities. Concurrently, customs officials will undergo training to effectively utilize these new technologies.

Strategic Coordinates of Customs Digitalization

The modernization process is built upon four priority pillars:

- **Interoperability and Integration:** Synchronizing the national IT ecosystem with that of the EU to ensure a bidirectional data flow, secured by state-of-the-art protocols.
- **Transition to "Paperless Customs":** Eliminating bureaucracy through instantaneous document processing, thereby reducing the need for the physical presence of economic operators.
- **Traceability through Dedicated Systems:** Utilizing platforms such as TSD-PN (Temporary Storage Declaration and Presentation Notification) for the end-to-end monitoring of goods, from the notification of arrival to the release for customs.
- **Data Integrity:** Adopting the electronic signature as a mandatory standard to guarantee the non-repudiation and authenticity of transactions.

Modernization of Customs Infrastructure and Institutional Convergence

The process of customs digitalization in the Republic of Moldova is aligned with the Digital Transformation Strategy 2023–2030 and the commitments undertaken through the National Customs Digitalization Program 2025–2030. The implementation of modern information systems aims to synchronize with the European digital architecture and ensure effective participation in common transit mechanisms and information exchange.

A central element of this transformation is the implementation of the **New Computerized Transit System (NCTS 5)**. This system allows for the electronic filing of transit declarations, automated data validation, and the transmission of standardized messages to the customs authorities involved in the operation. The process is conducted entirely in a digital format, from the initiation of transit to its discharge. By utilizing European standardized formats, the declaration is mutually recognized across states participating in the common transit procedure, eliminating the need to repeat procedures at each border crossing. From an economic perspective, this mechanism reduces transit times and the

uncertainty associated with deliveries. From an institutional perspective, NCTS ensures the integration of the Republic of Moldova into a shared digital network, representing a concrete step toward procedural convergence.

Complementarily, the **AES (Automated Export System)** and **AIS (Automated Import System)** fully digitalize export and import flows. These platforms allow for the pre-lodgment of declarations and the performance of risk analysis before the physical arrival of goods at the border. Consequently, customs control becomes selective and based on risk profiles, reducing generalized manual interventions. Real-time data exchange with European authorities strengthens interoperability and facilitates the mutual recognition of information.

The digitalization of border management is further enhanced by the implementation of the **Entry/Exit System (EES)**, which aligns the Republic of Moldova with European standards for border security and control. In parallel, the **Border Queuing System (BQS)** introduces digital scheduling for border crossings, effectively reducing wait times and congestion at customs checkpoints. This reduction in idling time has direct economic implications, as logistical costs are significantly influenced by the total duration of transit.

This process is consolidated through the digitalization of the **Authorized Economic Operator (e-AEO)** status. The recognition of "trusted traders" and the subsequent reduction in the frequency of physical inspections facilitate their integration into European value chains and bolster external competitiveness.

Impact on Competitiveness and Foreign Trade Structure

Recent statistical data indicate an increase in the Republic of Moldova's exports, but also a rise in the trade deficit. This evolution reflects structural vulnerabilities, including a dependence on low-value-added exports. While the digitalization of customs processes cannot, by itself, alter the structure of national production, it creates the necessary conditions for structural transformation.

By reducing transaction costs and increasing the predictability of deliveries, the business environment benefits from a more stable framework. Foreign investors are highly sensitive to administrative efficiency and the degree of interoperability with the European market. In this regard, customs modernization can function as a catalyst for attracting investment into export-oriented sectors.

However, the positive impact depends on complementarity with industrial policies and human capital development. Digitalization is a necessary but not sufficient condition for the structural transformation of the economy.

Challenges and Limitations of the Digitalization Process

The implementation of complex information systems involves significant financial investments and necessitates the strengthening of administrative capacity. Risks associated with cybersecurity, dependence on technological infrastructure, and the continuous need for staff training represent substantial challenges. In the absence of proper institutional adaptation, technological modernization may lead to temporary dysfunctions.

Consequently, digitalization must be accompanied by organizational reforms and the consolidation of an institutional culture oriented toward efficiency and transparency.

Conclusion

The analysis demonstrates that the digitalization of customs processes contributes significantly to the functional integration of the Republic of Moldova into the European Single Market. The implementation of interoperable systems reduces administrative barriers, consolidates procedural convergence, and enhances the predictability of foreign trade. Digitalization represents more than a mere technical modernization; it serves as an instrument of structural convergence with the European Union. However, to generate a sustainable economic impact, it must be integrated into a broader strategy for industrial development and export diversification.

In light of its European trajectory and status as a candidate country, the Republic of Moldova has earnestly assumed its requisite commitments. Consequently, the analysis of Moldova's economic

evolution for the year 2025 highlights an optimistic paradox: although the country has reached a historical peak in exports, their structure remains vulnerable due to a reliance on raw materials within the goods sector. The innovation of customs processes through advanced digitalization emerges not only as a technical necessity but as a strategic solution for overcoming this bottleneck. The integration of new systems generates a multiplier effect on the national economy through three fundamental directions.

Firstly, synchronization with European standards through digitalization eliminates "invisible" (non-tariff) barriers, allowing finished Moldovan products to compete in the Single Market without the burden of double bureaucracy, thereby facilitating the necessary transition from volume-based exports to value-added exports. Secondly, the resulting efficiency and competitiveness, achieved by reducing border wait times and lowering operational costs, transforms the Republic of Moldova into a predictable partner. In conclusion, the innovation of customs processes through digitalization constitutes an essential vector for European integration, contributing to the transformation of borders from spaces of administrative control into functional nodes of an interconnected economy.

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INNOVATION IN ECONOMIC DIPLOMACY: ACCELERATING THE REPUBLIC OF MOLDOVA'S EUROPEAN INTEGRATION

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Abstract: *This article aims to clarify the issue of using innovation in the economic diplomacy of the Republic of Moldova and its role in the country's integration process into the European Union. The author's hypothesis is that the use of innovative tools in economic diplomacy would have a direct effect on accelerating the country's European integration process. The article explains the concept of economic diplomacy, emphasizing the fact that for the Republic of Moldova, economic diplomacy is becoming an indispensable tool, with the help of which the country's economic interests are promoted. Economic diplomacy has the role of creating a positive image of Moldovan products abroad, thus stimulating exports, creating a favorable image of the economic and political climate, thus favoring the attraction of foreign investments and, last but not least, facilitating cooperation with European organizations and institutions. At the same time, the article clarifies the notion of innovation, emphasizing that it represents a set of activities through which new ideas are generated, developed and implemented, being dynamic, continuous and including stages such as research, experimentation, testing and application. Some innovative tools that could be used in the economic diplomacy of the Republic of Moldova are also proposed. Bibliographic analysis is used as a research methodology, as well as foreign policy documents provided by the Ministry of Foreign Affairs and European Integration of the Republic of Moldova.*

Key words: *New Economy, economic diplomacy, innovation, European integration, Republic of Moldova*

JEL: F50, O30, O19

Introduction

In the current context of international economic relations, and more precisely that of globalization and regional interdependencies, one of the instruments used by the foreign policy of a state that aims to develop economically, including through integration into markets on the international arena, is economic diplomacy. Under these conditions, economic diplomacy is becoming a major topical area for both the academic and research environment, as well as for actors involved in international relations.

Given the major changes occurred worldwide in the society for some years now - digitalization, the emergence of artificial intelligence, the exponential growth of mobile communications and number of Internet users, the contribution of ITC to economic growth and in creating jobs, the reconfiguration of working systems in companies and in business, generally, so that to benefit more effectively from new technologies, the accelerated development of e-commerce - there are being created the leverages of the transition from the Industrial to the Post Industrial Age.

The need for permanent cooperation, at the highest level, between economic and commercial diplomats of various countries, capable of responding to current challenges and transformations of the global economic activities, creates, in the context of developing the informational society concept, the notion of „New Economy". The „New Economy" is characterized by enhancing the embedding of knowledge into new products and services and by increasing the importance of learning and innovation. The art of diplomacy and negotiation is a necessary but not sufficient condition for the modern economic and commercial diplomat, operating in the New Economy". The movement of capital, taxation, the methods of supporting agriculture, the issues of environmental quality - are just

a few examples imposing the economic and commercial diplomat the duty to acquire additional skills and experiences, that can be achieved only after an intense process of specialization in these areas. At this point, the economic diplomacy is not just the attribute of career diplomats, but it appeals to national expertise in specific areas, from either the public or the private sector. Therefore, the economic and/or commercial diplomat becomes an interdisciplinary integrator, who aims to achieve the aims entrusted, by negotiating the product of the integration process through techniques that are specific to the „art of diplomacy". The collaboration and cooperation in the field will meet the countries' national economic interest through modern methods, techniques and innovative strategies, of foreign trade and economic diplomacy. At the same time, it will be taken into account that the mutations and metamorphoses suffered by economic diplomacy in the postmodern Era made possible the emergence of non-state actors alongside the state actors, that have no diplomatic protection, that are highly trained, and who act within and outside borders, and that create fair competition worthy of consideration.

The governance that will be able to create an organizational model making, primarily based on public-private partnership, with the real and clear ability to integrate the synergy of forces of the governmental and non-governmental entities, will be undoubtedly Smart Governance. The Smart Governance that will use the public-private partnership model in economic diplomacy, at the conceptual and functional level of commercial diplomacy as a variation of economic diplomacy, developed horizontally, will achieve great success for the country governed.

This fact, in addition to the interest shown in the specialized international doctrine in terms of redefining the traditional diplomacy in general, and also the economic diplomacy, in particular, encourages us to an entitled attempt to provide a definition, without pretending to be exhaustive: Economic diplomacy is the process of mutual conditioning between politics and economics to enhance the stability of an area through another, and which aims to satisfy the political and economic national interest negotiated at international level.

In another vein, if we refer to the specific case of the Republic of Moldova, then it can be said that economic diplomacy, in addition to being an instrument with which the country's economic interests are promoted, this mechanism also represents an important vector of the broad process that our country is going through, the European integration process. The role of economic diplomacy for the economy of the Republic of Moldova is to create a positive image of Moldovan products outside the country, thus stimulating exports, to create a favorable image of the economic and political climate, thus favoring the attraction of foreign investments and, last but not least, to facilitate cooperation with European organizations and institutions. In this context, economic diplomacy becomes a fundamental tool for accelerating and consolidating the European integration process.

The motivation for choosing this topic stems from the increasing role of economic diplomacy as a strategic instrument in supporting European integration, particularly through the promotion of innovation and the attraction of advanced technologies. In the context of structural economic vulnerabilities, energy dependence, and institutional fragility, the Republic of Moldova must capitalize not only on traditional economic tools, but also on innovation-driven approaches. Economic diplomacy thus becomes a key mechanism for facilitating technology transfer, fostering partnerships in research and development, and positioning the country within global value chains based on innovation.

The main goal of this research is to analyze the role and effectiveness of economic diplomacy in advancing the European integration process of the Republic of Moldova, with a particular focus on its capacity to support innovation. The study aims to examine how economic diplomacy contributes to attracting innovative investments, enhancing technological capabilities, facilitating access to European research and innovation programs, and supporting the transition toward a knowledge-based economy. At the same time, it seeks to identify the main challenges and opportunities related to

integrating innovation into economic diplomacy strategies within the current geopolitical and economic context.

In terms of methodology, the research is based on a qualitative approach, combining the analysis of academic literature, official policy documents, and reports issued by national and international institutions. Analytical and comparative methods are employed to assess the evolution of economic diplomacy practices and their impact on both European integration and innovation capacity.

Basic content

The European integration process of the Republic of Moldova represents one of the most complex and ambitious political and economic transformations in the country's recent history. The signing of the Association Agreement with the European Union in 2014 and the granting of candidate country status in 2022 have strengthened Moldova's European perspective, while also highlighting the need for coherent external and internal policies capable of meeting the requirements of the EU *acquis* and ensuring the sustainability of reforms. In this context, economic diplomacy becomes a fundamental instrument for accelerating and consolidating the European integration process.

Economic diplomacy constitutes a core component of any country's foreign policy, aimed at protecting and promoting national economic interests abroad. According to Bayne N. and Woolcock S. [2], economic diplomacy manages the tensions between politics and economics, between state and non-state actors, between international and domestic pressures, as well as between international negotiations and internal negotiation processes. This definition highlights the interdependence between traditional diplomacy and external economic policy, emphasizing the role of the state as the primary actor, while also underscoring the importance of cooperation with the business environment and civil society.

On the other hand, Saner and Yiu broaden the understanding of the concept by defining economic diplomacy as a mechanism for the strategic adaptation of states to the dynamics of globalization and international economic competition. From this perspective, economic diplomacy becomes a form of external governance that involves policies aimed at attracting investment, promoting exports, and integrating into global value chains [12, p. 311–333].

In the European context, the research of Okano-Heijmans [11] and van Bergeijk [3] analyzes economic diplomacy as an instrument of integrated foreign policy, used by the European Union to promote its economic and normative interests in its eastern neighborhood.

Economic diplomacy is a modern concept that covers a broad range of instruments and intervention activities carried out on behalf of the state or of internationally active power groups, which act to promote or defend economic interests in the fields of production, logistics, trade, the international circulation of goods and services, or the monetary and financial economy [8].

Researchers from the Republic of Moldova Țău, N. and Stegăroiu, V. consider that economic diplomacy represents an "organic component of foreign policy and of states' international activities, as economic interests have become a fundamental priority of foreign policy, directly influencing a state's ability to ensure its security, development, and influence on the international stage" [13]

It can therefore be argued that economic diplomacy has become an essential instrument for promoting national interests, strengthening economic security, and attracting foreign investment. Studying economic diplomacy from the perspective of European integration provides the opportunity to build an interdisciplinary conceptual framework at the intersection of political science, international relations, and political economy. At the same time, such research contributes to the development of theory regarding the role of small states in international economic networks and to the identification of diplomatic instruments adapted to the Eastern European regional context.

In its contemporary understanding, economic diplomacy goes beyond the simple commercial dimension and extends to attracting foreign direct investment, strengthening economic security, facilitating access to external markets, and building strategic partnerships. In essence, it reflects a state's capacity to transform diplomatic relations into economic opportunities and, conversely, to

leverage economic resources to strengthen its international standing. For the Republic of Moldova, this type of diplomacy is not merely an option but a strategic necessity, given the structural vulnerabilities of the national economy, energy dependence, and institutional fragility.

Through the mechanisms of economic diplomacy, the Republic of Moldova has the opportunity to diversify its exports, reduce dependence on traditional markets, attract investment capital, and become a more competitive economic actor in the region. Moreover, economic diplomacy facilitates access to European financial resources, technical expertise, and EU markets, creating the premises for accelerated economic convergence. The main directions that can be influenced by economic diplomacy are summarized in Figure 1.



Figure 1. Main directions that can be influenced by economic diplomacy

Source: Ministry of Foreign Affairs and European Integration, [www. mfa.gov.md](http://www.mfa.gov.md)

According to the Ministry of Foreign Affairs and European Integration, the objectives of the Republic of Moldova's economic diplomacy are [9]:

- Promoting the economic interests of the Republic of Moldova abroad;
- Attracting foreign investment and new technologies into the national economy;
- Promoting a favorable economic image of the country;
- Attracting external economic assistance;
- Developing cooperation with international economic organizations;
- Optimizing the economic cooperation of the Ministry of Foreign Affairs and European Integration with national governmental institutions to successfully implement the objectives of economic diplomacy.

On the other hand, the role of economic diplomacy in the European integration process of the Republic of Moldova should be analyzed not only as a sectoral dimension of foreign policy but as a central pillar of the European path. It serves both as a catalyst for internal economic transformations and as an instrument for strengthening the country's international credibility in a complex and often unpredictable geopolitical environment. Understanding this interdependence is crucial for formulating effective public policies and for capitalizing on the opportunities offered by European integration.

In parallel, innovation systems theory emphasises the role of interactions among government, industry, and academia in generating technological change and economic growth. According to this view, the effectiveness of innovation depends on the capacity of institutions to absorb knowledge, foster collaboration, and participate in international networks. Innovation is no longer just a domestic economic priority; it has become a central theme in international relations and diplomacy. As argued

in research on innovation policy within diplomatic contexts, the global distribution of innovative activities affects international collaboration and competition, influencing diplomatic agendas and economic strategies. In this regard, integrating innovation into economic diplomacy facilitates deeper cooperation and strengthens a state's position in international negotiations, especially with supranational entities like the EU.

Before referring to any innovative directions in the economic diplomacy of the Republic of Moldova, it is important to clarify the concept of innovation. There are several ways in which innovation can be defined. It can be understood as a process of improvement through the introduction of novelty, as the simple introduction of something new, as a change that generates a new level of performance, as a creative idea that is put into practice, or as the continuous ability to achieve a desired future state. According to the specialized literature, innovation refers to "the process itself—namely the set of activities through which new ideas are generated, developed, and implemented. It is dynamic and continuous, and it includes stages such as research, experimentation, testing, and implementation" [1]. Collins and Amabile consider that innovation "begins with creative ideas, creativity being a necessary but not sufficient condition for innovation" [4].

In economic, administrative, and social contexts, innovation refers to the introduction of meaningful and substantial novelty within a specific field, rather than minor or superficial changes. It includes both radical and incremental transformations of products, processes, services, and organizational paradigms. From this perspective, innovation is a multidisciplinary concept, addressed in economics, business studies, sociology, and technology, and is widely recognized as a key driver of contemporary economic development.

Innovation contributes to value creation and is closely linked to performance and growth, as it enhances efficiency, productivity, quality, and competitive positioning. At the same time, it may also have a disruptive character, replacing established structures, practices, and models, which implies a certain level of risk [10].

Returning to the role of innovation in the economic diplomacy of the Republic of Moldova, in order to accelerate European integration, the Republic of Moldova must shift from reactive economic diplomacy to an innovative, strategic, and results-oriented one with measurable outcomes.

Economic diplomacy should increasingly focus on microeconomic factors of competitiveness, particularly innovation, as a key driver of sustainable growth. By promoting technological capabilities, knowledge transfer, and international collaboration, it enhances the global positioning of innovative firms. In this way, economic diplomacy acts as a strategic bridge between national innovation systems and international markets [7].

The table 1 outlines several innovative directions that could be leveraged in the economic diplomacy of the Republic of Moldova.

In the same vein of logic, the success of integration into a global value chain depends decisively on a country's innovative competitiveness. According to a study conducted by Moldovan researcher Marica Dumitraşco, the Republic of Moldova's high-tech exports are concentrated in a few segments, such as medicinal and pharmaceutical products, as well as electrical machinery and their components. The study also shows that the country's participation in global value chains is predominantly of the "backward" type—that is, it relies more on external inputs than on the internal generation of added value.

Table 1. Innovative directions that could be used in the economic diplomacy of the Republic of Moldova.

N.o.	Directions	Description
1.	Digitalization of Economic Diplomacy	It is necessary to use digital platforms to promote exports, showcase investment opportunities, facilitate B2B contacts, and monitor external markets. A data-driven economic diplomacy can more rapidly identify promising sectors and barriers to entry in the EU market.

N.o.	Directions	Description
2.	Smart Sectoral Specialization	Economic missions and external representations should prioritize the promotion of sectors in which the Republic of Moldova has or can develop competitive advantages: high value-added agri-food, IT, electrical components, digital services, creative industries, pharmaceuticals, and green technologies.
3	Integrating Innovation into Foreign Economic Policy	Economic diplomacy must be aligned with national policies on research, innovation, education, and industrial development. Embassies and economic offices can become platforms for connecting Moldova's innovation ecosystem with European partners.
4	Strengthening cooperation between the state, academia, and the business sector	An effective approach involves a "quadruple helix" model, in which the state, universities, the private sector, and civil society collaborate to internationalize the economy and capitalize on European opportunities.
5	Promoting the country's economic brand	The Republic of Moldova needs a coherent external economic narrative centered on reliability, European proximity, flexibility, creativity, and innovation potential. Economic diplomacy is not only about negotiation, but also about building a credible and attractive economic image.

Source: Author's creation based on bibliographic sources

This finding is quite relevant for economic diplomacy. If the Republic of Moldova aims for accelerated and sustainable European integration, it is not enough to increase the volume of exports; it is necessary to improve their qualitative structure, move up the value chains, and promote innovative sectors capable of generating a lasting competitive advantage. Therefore, innovative economic diplomacy must become a vehicle for structural transformation, directing external efforts not only toward market access, but also toward technology transfer, research partnerships, the development of creative industries, the internationalization of innovative SMEs, and the attraction of investments with technological impact [6].

Another relevant aspect of modern economic diplomacy is the capitalization of creative industries and creative goods in international trade. According to a recent study conducted by Moldovan researcher Mariana Damaschin, foreign trade in creative goods can have a positive impact on the economic stability of the Republic of Moldova by diversifying exports, increasing added value, and reducing vulnerability to external shocks [5].

This perspective is particularly important in relation to European integration, as the European Union is increasingly promoting a knowledge-based economy driven by innovation, creativity, and digitalization.

In the same vein, we believe that through the economic diplomacy of the Republic of Moldova it is important to promote at the international level sectors that use innovation and creativity, sectors such as design, cultural products, IT, digital services, media industries and branding of domestic products. In addition, creative goods and innovative products contribute not only to the performance of exports, but also to the external image of the state. In an era when economic reputation influences investments and partnerships, economic diplomacy must go beyond the classic paradigm of trade promotion and include elements of country image, economic soft power and innovation diplomacy.

It is important to emphasize that the Republic of Moldova already has a functioning economic diplomacy. The question, however, is how effective it currently is. The concern addressed in this article also relates to the aspect of innovation, and more specifically how, through innovation, the efficiency of economic diplomacy can be increased in order to attract foreign investment, export Moldovan products and services, and develop the country's economy.

A first step would be to assess the current state of economic diplomacy, to continue the good practices, to improve what works less well, and to draw inspiration from best practices while adding new and innovative elements to maximize the efficiency of the country's economic diplomacy.

Conclusions

The economic diplomacy is a matter of national security from an economic perspective. The economic diplomacy, in the current international context, has turned into a real distinct branch of diplomacy, and as a result of globalization, it was supported and driven by an increase in the importance of economic affairs, which clearly did not affect the nature of diplomatic missions, on the contrary, it brought them new meanings. Thus, the traditional commercial diplomacy undergoes a metamorphosis as a result of the elevation process, and migrates, configuring accurately the term of economic diplomacy in a more comprehensive sense, and integrating the financial component as well, in addition to traditional commercial exchanges.

The role of this article is to dive deeper into the impact of innovation as a strategic driver within the economic diplomacy of the Republic of Moldova, specifically its importance on accelerating the country's European integration process.

After writing this article, it can be concluded that economic diplomacy is an important component in the European integration process of the Republic of Moldova. An economic diplomacy, based on intelligence, research and innovation, can make a considerable contribution to increasing the competitiveness of our country, to increasing the exports of Moldovan goods and services to the European Union market, but also to attracting foreign investments. Accelerating European integration depends not only on political will, but also on the capacity to innovate institutionally, to connect the national economy to European value flows and to transform the advantages of proximity into concrete development results.

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DIGITAL ENERGY GOVERNANCE AND SMALL-STATE ENERGY SECURITY: DIGITAL POLICY AND INSTITUTIONAL CAPACITY IN MOLDOVA'S ENERGY TRANSITION

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Abstract: *In recent years, driven by global energy transition and geopolitical competition, energy security has become a central issue in international political economy. The Russia–Ukraine conflict has profoundly reshaped Europe's energy landscape, highlighting the structural vulnerabilities of small Eastern European states along geopolitical fault lines in terms of energy structure and governance capacity. Using Moldova as a case study, this paper explores how digital policies can be transformed into a novel form of institutional capacity for small states to address limited physical resources and asymmetric interdependence. The study finds that digitalization of energy systems, through virtual peak-shaving mechanisms, effectively compensates for deficiencies in physical storage and infrastructure, providing an institutional substitute for external energy dependence. Moreover, digital transformation reconstructs the state's knowledge-power structure by reducing information asymmetry, enhancing governmental regulatory capacity and capital attractiveness. Digital platforms also act as technical interfaces connecting small states to regional multilateral rules, and through deep institutional alignment with the European Union, reinforce strategic energy security. The paper highlights the role of digitalization as a tool of sovereignty empowerment, offering new theoretical insights and empirical evidence for understanding how resource-constrained small states navigate energy security challenges in complex international environments.*

Key words: *Energy Transition; Energy Security; Digital Energy Governance; Renewable Energy; Moldova*

JEL: Q48, F52, P28.

Introduction

The global energy system is undergoing a structural transformation driven by the urgency of climate action, the fragility of energy security, and escalating geopolitical tensions, prompting states to reconfigure their energy governance models (Kuzemko et al., 2020). The 2022 Russia–Ukraine conflict not only represents a regional war but also signifies the collapse of Europe's reliance on cheap external energy. As energy becomes increasingly weaponized, Eastern European states along geopolitical fault lines are compelled to redefine national security under heightened uncertainty, elevating energy transition from a carbon-neutral objective to a core instrument of strategic resilience. In this context of global power reconfiguration, small economies face disproportionate constraints: limited infrastructure, narrow domestic markets, and restricted fiscal capacity place them at a structural disadvantage within asymmetric interdependence, weakening their bargaining power and shock-absorption capacity. From a structural power perspective, as articulated by Susan Strange, this

subordinate position reflects deficiencies in key domains such as knowledge, finance, and security, rendering small states largely passive rule-takers in international energy governance.

Moldova constitutes a paradigmatic manifestation of this structural predicament. Historically reliant on a single external source for electricity and natural gas, the country's energy system has, in the wake of the 2022 Russia–Ukraine conflict, been exposed to acute uncertainty and heightened risks of supply disruption, exemplifying the vulnerability and sensitivity dimensions articulated in complex interdependence theory (Keohane & Nye, 1977). In response, the Moldovan government has advanced a set of comprehensive reforms aimed at mitigating external exposure through electricity market liberalization and infrastructure modernization. Within this framework, energy digitalization has transcended its technical function to emerge as a pivotal institutional lever, entailing not merely the deployment of smart grids and metering technologies but a reconfiguration of energy governance boundaries (Sioshansi, 2019). Under conditions of constrained physical resources and limited fiscal capacity, Moldova seeks to operationalize data as a strategic production factor to enhance allocative efficiency, improve market transparency, and facilitate regulatory convergence with the European Union, thereby enabling a form of institutionalized digital sovereignty.

However, existing scholarship has largely focused on macro-level transition pathways or the diversification of physical energy supplies, leaving the question of how energy digitalization can be transformed into a novel form of institutional capacity for small states underexplored. This paper posits that digitalization provides a critical institutional compensatory mechanism, enabling small states, despite limited traditional power, to enhance administrative effectiveness and policy agency in the energy sector through precise governance and rule integration (Xu et al., 2022). From this perspective, the study conducts an in-depth analysis of Moldova's transition practices, examining how digital policies reconstruct the energy security framework of a small state navigating the dual challenges of high dependency and resource scarcity. By qualitatively exploring the interaction between technology and institutions, the paper aims to illuminate the profound implications of digitalization as a tool of sovereign empowerment, demonstrating how small states can leverage technological upgrades to strengthen institutional capacity and secure higher-order protections within geopolitical fault lines.

Literature Review

In contemporary scholarship, "energy transition" has moved beyond a purely technical shift from fossil fuels to low-carbon systems, evolving into a central variable in geopolitical contestation and the reconfiguration of national security strategies (Cherp & Jewell, 2014). Existing studies suggest that energy security is determined not only by the physical continuity of supply but also by the degree of source diversification (Ang et al., 2015). However, for small states constrained by limited natural resources and fiscal capacity, the conventional pathway of achieving energy independence through large-scale physical infrastructure expansion is increasingly restricted by both institutional and economic barriers. Along the Eastern European geopolitical fault line, these constraints materialize as structural vulnerability. In responding to external energy shocks, the lack of physical buffering capacity often relegates such states to the margins of power within asymmetric interdependence (Goldthau & Sitter, 2015). This imbalance can be further interpreted through Susan Strange's theory of structural power: the subordinate position of small states in the international energy system ultimately stems from persistent deficiencies across the four key structures—finance, security, production, and knowledge—thereby limiting their agency in the formulation and implementation of energy governance rules (Strange, 2015).

With the rapid development of information and communication technologies, modern energy systems are undergoing a digital transformation from unidirectional physical networks to deeply integrated "cyber-physical" infrastructures (IEA, 2017). Digitalization extends beyond the physical deployment of intelligent hardware to represent a new data-driven logic of energy governance. Studies indicate that digital technologies can effectively mitigate physical bottlenecks, enhance system performance,

and provide technical buffering for the large-scale integration of intermittent renewable energy sources. More importantly, digital platforms reduce information asymmetries in energy markets, increase transaction transparency, and lower market entry barriers, thereby enabling small states with limited bargaining power to attract external capital and optimize resource allocation (Hafner & Tagliapietra, 2020). In this context, digitalization is conceived as an “institutional tool” that compensates for deficits in physical resources, offering small states a novel pathway to achieve governance effectiveness in the energy sector.

However, how small states can actively reshape their governance capacity within the international energy system remains an underexplored area. Although small states are often characterized as passive rule-takers (Thorhallsson, 2018), energy governance theory emphasizes that governance is fundamentally a dynamic process of institutional arrangements and multi-actor coordination (Florini & Sovacool, 2011). In the digital era, the center of governance is shifting toward “data-driven” approaches and “institutional agility.” For Moldova, balancing the vulnerabilities inherent in interdependence (Keohane & Nye, 1987) with the institutional opportunities presented by digital transformation has become a frontier of academic inquiry. Empirical studies on Eastern European small states remain scarce, particularly regarding how digitalization functions as an “institutional compensatory mechanism” to mitigate physical vulnerabilities. Accordingly, this study seeks to integrate insights from structural power, complex interdependence, and energy governance theories to examine how digital policies can reconstruct small states’ institutional capacities, thereby enabling higher-order sovereign security in unstable geopolitical environments.

This study conceptualizes energy digitalization as a “mechanism for generating institutional capacity.” As illustrated in Figure 1, digitalization operates through three interrelated pathways. First, the information transparency mechanism reduces market transaction costs by integrating real-time data and alleviating information asymmetries. Second, the regulation and optimization mechanism strengthens the state’s core coordination function in energy dispatch through data-driven forecasting capabilities. Third, the regulatory alignment mechanism achieves institutional isomorphism with regional (EU) energy markets via data standards and technical interfaces. Together, these three mechanisms synergistically drive the evolution of institutional capacity, enabling small states to achieve substantive improvements in energy security through governance optimization, even under the rigid constraints of limited physical resources (Ha, 2022).

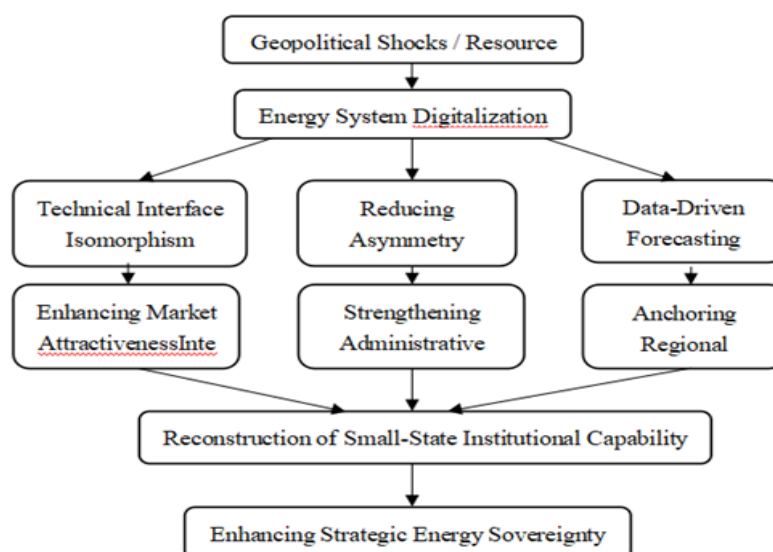


Figure 1. Logical Framework: Digitalization as an Institutional Capability
 Source: Compiled by the author

Methodology

This study employs a single-case study approach, using Moldova's recent energy transition practices as an in-depth empirical example. Single-case research offers substantial explanatory power for investigating "how" and "why" questions, particularly when analyzing highly complex processes of institutional change and policy innovation (Yin, 2018). Moldova, as a small economy under intense geopolitical pressure and severe resource constraints, provides a representative and critical case for examining the rapid digital-driven transformation of energy governance. This design allows the study to closely observe the internal logic of policy implementation and to analyze how digitalization functions as an institutional variable that is activated under specific external pressures and translated into enhanced state governance capacity. By qualitatively exploring this illustrative case, the research aims to extract generalizable insights into how small states can achieve significant leaps in energy governance despite structural vulnerabilities.

In terms of data collection and processing, this study adheres strictly to a multi-source triangulation approach to ensure the reliability and validity of its findings. The empirical materials are composed of three main components. First, official policy documents are analyzed, with particular emphasis on the Moldovan government's recently approved "Digital Transformation Plan for the Energy Sector 2026–2030," which provides a primary basis for understanding national strategic intent. Second, third-party international assessment reports are incorporated, notably those produced by the United Nations Development Programme (UNDP) and the International Energy Agency (IEA), which offer systematic evaluations of Moldova's energy reforms and document institutional feedback as well as external appraisals during policy implementation (UNDP, 2024). Third, cross-dimensional statistical data are utilized, including the latest figures on energy structure and installed capacity published by the National Sustainable Energy Center of Moldova. By triangulating governmental strategic narratives, expert assessments from international organizations, and objective market evolution data, this study seeks to reconstruct a dynamic and multidimensional picture of digital energy governance. To ensure analytical rigor, this study employs content analysis and process tracing in examining the collected qualitative data (Lee et al., 2022). By identifying key terms and underlying logics in policy texts, particularly those related to power reconfiguration, market transparency, and regulatory alignment, it investigates the pathways through which digitalization evolves from technical deployment into institutional capacity. This research design goes beyond assessing the introduction of digital technologies per se, focusing instead on how these technologies are embedded within Moldova's existing governance structures and how they ultimately reshape the boundaries of energy security under conditions of complex interdependence, thereby offering a deeper interpretation of the logic of institutional evolution.

Case Analysis: Digitalization and Institutional Reconstruction in Moldova's Energy Transition

Moldova's energy transition exemplifies the extreme sensitivity and vulnerability described in complex interdependence theory. For a long time, the country's natural gas and electricity supplies were almost entirely dependent on a single dominant external supplier, creating a highly asymmetric interdependence. This left Moldova with minimal physical buffers to withstand supply disruptions or price spikes in the face of geopolitical shocks such as the Russia–Ukraine crisis. In response, the Moldovan government demonstrated strong strategic execution by aggressively expanding the domestic renewable energy system. Installed capacity grew from approximately 77 MW in 2020 to an anticipated near 1 GW by the end of 2025, representing more than a twelvefold increase within just five years (NSEC, 2025). Solar energy (approximately 72%) and wind energy (approximately 25%), driven primarily by fixed-price and net-metering policies, have become the core pillars replacing traditional fossil fuels (UNDP, 2023). However, this rapid physical transformation, aimed at reducing external vulnerability, has generated new systemic risks at the national grid level. The highly intermittent and fragmented nature of renewable integration exceeds the physical absorption

capacity of Moldova's traditional, coarse-grid infrastructure. These technological bottlenecks have compelled Moldova to pursue governance solutions that extend beyond mere infrastructure expansion, seeking mechanisms capable of sustaining its geopolitical objective of energy independence.

Faced with the physical limitations of the traditional grid and constrained national fiscal capital, the Moldovan government, with international support, introduced the Digital Transformation Plan for the Energy Sector (2026–2030) (Ministerul Energiei al Republicii Moldova, 2024), which carries implications beyond mere technological upgrades. From the perspective of Susan Strange's structural power, the passive position of small states in international energy competition stems from their relative weakness in financial and security structures. Unable to invest in large-scale storage facilities or redundant pipelines as major powers can, Moldova has opted to leverage digital policies to reshape the knowledge structure—specifically, the control over data and information flows—as an institutional compensation for physical shortcomings. The strategic core of this initiative involves the large-scale deployment of 500,000 smart meters by 2030 (covering at least 40% of key users) and the establishment of a national energy data hub, representing a governance-driven restructuring of authority aimed at eliminating information asymmetries (UNDP, 2024). By collecting and integrating real-time data on energy production, imports, and consumption, national regulatory agencies have shifted from a traditionally reactive, fragmented approach to proactive, algorithm-based management. This process of data transparency not only effectively reduces rent-seeking opportunities in conventional energy transactions and keeps grid losses below 10%, but more importantly, it consolidates energy dispatch authority within the state governance platform, significantly enhancing administrative control over energy flows and distribution.

The comprehensive deployment of digital infrastructure has ultimately translated into tangible governance capacity for Moldova to hedge against external risks. Within the framework of energy governance theory, this capacity manifests as the integrated management of system agility and market rules. Under traditional physical constraints, power grids face instability when intermittent renewables exceed approximately 15% of the energy mix (IEA, 2017). Moldova, however, has successfully surpassed this limit through digital-enabled demand-side management and intelligent dispatch. Data indicate that, supported by digital mechanisms, renewable electricity accounted for 16.7% of total consumption in 2024 and rose to approximately 24.5% by 2025, with instantaneous generation during peak seasons covering more than 48% of domestic demand (NSEC, 2025). This high level of grid integration reflects the role of digitalization as a "virtual balancing tool," where precise control over consumption behaviors substitutes information flows for physical storage, upgrading national energy system resilience at minimal economic cost.

Strategically, digital platforms have also served as critical technical interfaces for Moldova's institutional alignment with the European energy community (Petelca et al., 2024). By binding domestic data standards to EU transparency rules, such as those of ENTSO-E, Moldova has not only achieved cross-border grid integration physically but also accomplished deep regulatory harmonization with European governance frameworks. Anchoring national energy security within broader regional rules, this strategic approach demonstrates that digital transformation is not merely a tool for enhancing technological efficiency in small states; it is a central vehicle through which they can assert sovereignty and evolve institutional capacity within volatile geopolitical fault lines.

Conclusion

This study, through an in-depth analysis of Moldova's energy transition, highlights the central role of digitalization in enabling small states to address structural vulnerabilities (Nica, Georgescu & Kinnunen, 2026). The findings indicate that, amid the rapid restructuring of the global energy system, Moldova has successfully shifted the logic of energy security from mere physical resource expansion to data-driven, precision governance by deploying smart grids, national data hubs, and smart metering

devices. This transformation has not only resolved the technical challenge of integrating high shares of intermittent renewables but also digitally empowered the state's sovereign capacity at the institutional level. By functioning as an institutional compensation mechanism, digitalization allows Moldova to leverage the mobility of information flows to hedge against external geopolitical risks, thereby enhancing strategic resilience within asymmetric interdependence.

Building on Moldova's successful experience, this study offers policy insights for other small economies facing similar structural vulnerabilities. First, small states should elevate energy digitalization to a national security priority. In an international environment where energy is increasingly weaponized, establishing real-time monitoring and predictive systems for energy flows can effectively reduce sensitivity to external suppliers while preserving essential administrative control. Data sovereignty is becoming an integral component of energy sovereignty; by exercising autonomous control over energy production and consumption data, small states can transform from passive rule-takers into agile governance actors (Proedrou, 2018). Second, digital transformation should be leveraged as a technological bridge for alignment with mainstream international institutions. By achieving mandatory harmonization of digital standards with regional multilateral mechanisms, such as the European energy community, small states can substantially lower institutional entry barriers and risk premiums in international energy markets, breaking the long-standing structural constraints imposed by limited financial capacity. Finally, digital governance must be closely integrated with social equity and justice. Using precise data to identify and support energy-vulnerable populations ensures that the social costs of energy transition are distributed fairly, thereby maintaining overall national resilience under high-pressure conditions (Sovacool, 2016).

While this study offers a framework for understanding Moldova's digital energy governance, several boundary conditions must be acknowledged. Primary among these is the specificity of the Moldovan case. The country's trajectory is inextricably linked to its unique geopolitical position and the institutional "pull" of EU integration. Consequently, the extent to which these digital strategies can be replicated in small states outside the European orbit warrants further comparative inquiry. Furthermore, while the narrative here emphasizes institutional empowerment, it arguably underplays the "shadow side" of digitalization. Issues such as cybersecurity vulnerabilities, data privacy, and the risk of path dependency on external technology providers remain critical gaps. Lastly, as Moldova's energy transition is a "living" process, these findings represent a snapshot in time. Only longitudinal observation will reveal whether these digital gains can withstand long-term political and economic pressures.

Ultimately, Moldova's trajectory in digital energy governance offers a vital lens through which to view the survival strategies of small states operating within the friction of geopolitical fault lines. While the structural tension between technological autonomy and external reliance remains a persistent challenge, the Moldovan experience demonstrates that leveraging digital upgrades to catalyze institutional "leaps" is a potent, and perhaps essential, mechanism for securing energy sovereignty in a fragmented international order. Moving forward, the scholarly agenda must expand to interrogate how these digital governance models fluctuate across diverse political regimes and the extent to which emerging transnational technical standards might fundamentally reorder the global hierarchy of energy power.

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THE STRATEGIC ROLE OF RAILWAY TRANSPORTATION IN THE FOREIGN TRADE OF THE REPUBLIC OF MOLDOVA

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Abstract: *This paper analyzes the foreign trade of the Republic of Moldova and aims to highlight the strategic role of the railways in this process. The research methodology consisted of statistical data analysis and review of relevant theoretical sources. According to available statistical data, Moldova's trade is oriented towards the western markets. The most exported products are insulated wires and agricultural products, while the most imported ones are fossil fuels and electronics. The main transport mode used in trading is the road transport, also being the most accessible and flexible one. The railway transportation has a lower carbon print and is often cost optimal. The most imported and exported goods are typically resistant to spoilage and suitable for long distance transportation. Unfortunately the national railway system is not completely compatible with the EU one, creating a disadvantage in Moldova's foreign trade and TranEuropean integration. A modern railway system would allow local businesses to export or import products with a lower carbon print and more efficiently. During this research was defined the contemporary trade orientation of the Republic of Moldova, alongside with the National Railway system's flaws that prevent the efficient usage of this transportation mode. By overlapping this data, it was possible to determine the necessary improvements that will enhance the strategic role of the railway transportation in the foreign trade of the Republic of Moldova. The European Mechanism of Integration focuses not only on the process itself but also on durability and resilience of the applied measures.*

Key words: *foreign trade, railways, commerce, transportation, train, logistics, integration*

JEL: F18; F02; F55; F67

Introduction

No country could enjoy prosperity in isolation, there is always a need for cooperation with its neighbors and other nations. Foreign trade is essential for a healthy economy. It allows supplying goods to a nation that naturally doesn't have access to it or has it in a smaller amount, while the excess internal product can also be exchanged. Transportation plays a key role in foreign trade, for it allows the goods to be moved from one country to another, meanwhile also being one of the main sources of pollution.

No country in the world will stop the transportation of goods to reduce the greenhouse gas emissions. This is where the concept of green logistics appeared, at the intersection of two needs, freight transport and the reduction of carbon emission. Green logistics promotes sustainable, resilient and often cost efficient transport modes. One of the most effective green logistics transportation is rail mode.

The research goals of this paper are:

- To determinate the main trade direction
- To analyse the current state of national railway system
- To define the strategic role of the rail mode in Moldova's foreign trade

The methodology used for this research implied the analysis of statistical data and study of relevant theoretical materials.

The Republic of Moldova has built a strong market relationship with its neighbors and EU member states. The goods are constantly imported from and exported to the western market. The trade towards EU countries is significantly higher than non EU members.

Railway transportation is known for its emission efficiency, low costs, and big load capacity. The Republic of Moldova has an old railway network that doesn't always respond to contemporary trade needs, but even this way it still has an important strategic role in the national economy. A further improvement of the national railway network would have a great impact on Moldova's foreign trade and economy.

Basic content

Trade is extremely necessary for a healthy economy and building a nation's wealth. One of the negative effects of this process is pollution through carbon dioxide emissions. To reduce the impact of emissions on nature, countries use diverse transportation modes that allow cutting the costs, move goods more efficiently and reduce the emissions as much as possible. Trains are known for being cost efficient and have a lower greenhouse gas emissions, while having a bigger load capacity than road transportation. A big disadvantage of this transportation mode is the infrastructure, unlike road transport, trains need a built railway line. The train mode accessibility depends completely on the existing railway lines system.

The contemporary foreign trade of the Republic of Moldova is western oriented, the western markets not being very accessible through the rail system. The Moldovan railway network was intensively developed during soviet occupation, and reflects the trading objectives of that era. It was built with a soviet gauge of 1520 mm, which limitates access to the European lines that were built with a standard 1435 mm gauge. This reduces the train usage, a sustainable transport mode, in the favor of road transport, a more polluting one.

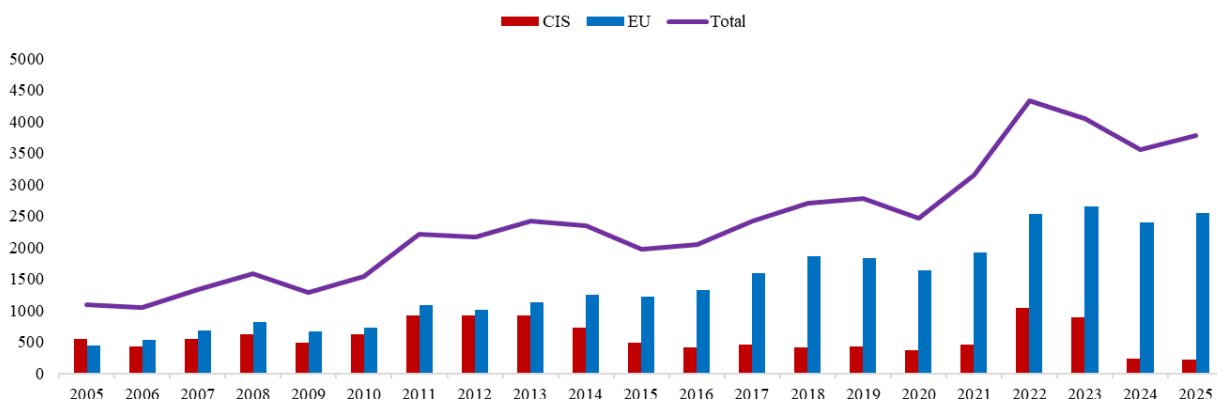


Figure 1. The Republic of Moldova's export, 2005-2025, mil USD

Source: made by author based on BNS

Right after gaining its independence, the Republic of Moldova was mainly exporting its products to the former soviet republics, with whom there was already built an economical relationship. In the past two decades though, the exports to European Union member countries have constantly exceeded the Commonwealth of Independent States one, the EU member states becoming the main strategic partners. "For Moldova, access to foreign markets is an essential factor driving the growth of exports. In this context, regional integration is a phenomenon that stimulates penetration into new markets, attracts foreign investment, and promotes economic development." [Antoci, 2018] Penetrating the European markets meant a step further for the Moldovan foreign trade. At first, the switch to a new market was a bit forced. First in 2006 by the first Russia embargo on wines, at that time 80%-90% of Moldovan wines were exported to the Russian Federation. Then again in 2014 by the second Russian embargo. However, the impediments created for Moldova on eastern markets only moved it even further on the new western ones. It created a situation in which the only survivors were those who decided to adapt, evolve and enter the western markets.

Table 1. The Republic of Moldova's export, 2020-2025, mil USD

Year	2020	2021	2022	2023	2025
Total Export	3 144.5	4 332.1	4 048.6	3 555.1	3 782,7
CIS Export	466.2	1 043.0	897	241.6	224.2
EU Export	1 919.5	2 537.5	2 646.7	2 392.4	2 554.4

Source: BNS

During 2020-2025, the level of the Republic of Moldova's exports fluctuated between 2.4 billion and 4.3 billion USD, reaching a peak in 2022 when the export value was 4.33 billion US dollars. According to the National Bureau of Statistics of the Republic of Moldova, exports to the EU significantly prevail over those to the CIS. In 2025 the value of exports towards the EU exceeded the CIS one 11 times.

When analyzing the export by countries, Romania comes up as the main foreign market, 30% of Moldova's exports are directed to its neighbor. The second export share by country is held by the other neighbor, Ukraine, where 8% of export value is distributed.

The insulated wires account for 12% of the total export value, which is the biggest share for a single product. The greatest group of products, however, are agriculture ones: sunflower seeds - 7%, wheat -6%, corn-2% and so on. Cumulatively agricultural products generate over a quarter of the export value.

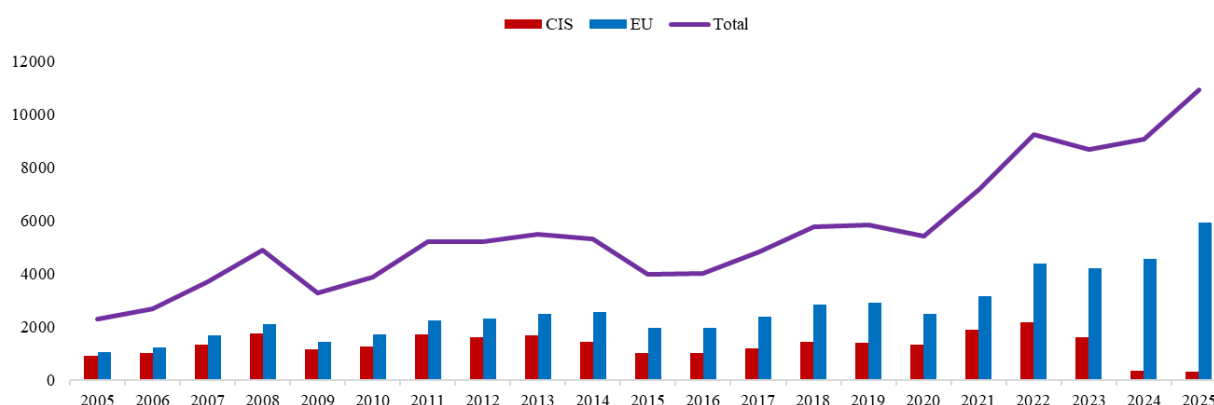


Figure 2. The Republic of Moldova's import, 2005-2025, mil USD

Source: made by author based on BNS data

The Republic of Moldova's imports are also mainly coming from the west. In 2024 and 2025 the CIS import value dropped drastically, being four-five times lower than in 2023.

When analysing the import origins, the neighbors, Romania and Ukraine, come up with the biggest import share, alongside with China. 18% of imports originate from Romania, 13% from China and 12% from Ukraine.

According to The Observatory of Economic Complexity, the greatest import value is generated by the refined petroleum and petroleum gas, accounting for 10% and 5% respectively. Mineral fuels, oils, waxes and its distilled derivatives hold a share of over 16% of the total import value. The second category by its value is electrical machinery and electronics, representing 11% of the import, and incorporating products like: telephones -3%, insulated wire-2%, computers-1%, refrigerators-1%, and so on.

By analyzing the foreign trade it is clear that the main trading partners are the neighboring countries and EU member states. This is a very important aspect because it dictates the transportation modes that could be used. The most popular and accessible one is road transportation. It is easy to contract,

only requires vehicle maintenance and a functional road. The load capacity of road transportation is lower compared to trains, and might require multiple transport units which means a higher cost. "Regarding goods exports, railway transport accounted for only 1.5% of the total, thus occupying a marginal position compared to road transport, which dominates the export structure with 81.2%, and maritime transport, which contributes 14.2%." [Stancu, Burlui, 2025]

Green logistics is a massive and complex concept that borders both economy and ecology and tries to find a solution for climate change that is not only efficient but also financially acceptable. Transportation is a huge source of urban pollution but at the same time it's indispensable for economic activity. Big corporations are implementing green logistics strategies to reduce the carbon emission, cut operational costs and use that as a base for green marketing. The young consumers tend to support cooperative responsible companies.

The need for a cost efficient, resilient and sustainable transport mode is what gives railway transportation such an importance. The rail mode fits all the needed criteria: sustainable, low cost, resilient.

When it comes to sustainability, trains are known for a lower carbon emission per loaded cargo compared to road transportation. Moreover, trains can run not just on fossil fuel, there are also hybrid trains that have even a lower carbon emission, and electric trains with zero emissions.

The cost efficiency comes from big load capacity. The bigger the loading of a train is, the lower the cost per transported unit will be. And usually the capacity of one train is a few times bigger than one of a truck.

The resilience was proven decade by decade. Once built, a railway line serves decades, if maintained properly of course. The train is not held back by: rains, storms, snowfalls, fog, etc, unless the severity of those is extremely unusual.

The railway transportation's potential is not valued completely and the current state of Moldovan national railway network is not motivating. The local rail lines were built to achieve a different trade objective than today's. The gauge is too wide, the soviet 1520 mm instead of the standard 1435 mm, which means longer time spent at the border for train adaptations. The complete absence of electrical line which makes the usage of electrical trains impossible. The only ones to fit are fuel and hybrid ones, but the CFM does not register hybrid trains in its possession, only fossil fuel ones.

The current state of the national railway network is not highly attractive for potential exporters or importers. The lack of innovation and modernization caused a decrease in rail mode usage, this eventually created some financial difficulties for CFM. The Railway of Moldova held unused assets, which over the years were put up for auction, including containers produced in the USSR between 1983 and 1991, whose value ranged from under 2 000 to over 12 000 MDL. Furthermore, the administration conducted auctions for the lease of assets that were not used in the operational process, including repair facilities, ticket offices, administrative buildings, and loading-unloading ramps. These real estate assets remained unutilized due to the decline in railway operations.

The national railway system requires changes and modernizations before it could be valued at its full potential. "Although freight railway transport initially faces challenges such as slower transit times and infrastructure harmonization, long-term operational savings and compliance with environmental requirements outweigh these disadvantages" [Hamuraru, Bulat, 2026] Starting a massive transition from road transportation to rail mode will take a lot of time and effort. The main factor that could drive a shift in logistic preferences is corporate responsibility. Companies try to reduce the greenhouse gas emissions caused by operational processes. Transport is one of the main polluting factors and this is where the concept of green logistics kicks in.

Innovating the national railway systems will make it more attractive for local companies that export in the neighboring countries and EU. A switch from road transport to rail mode will have a positive impact on the environment, for the trains are more sustainable than road transportations. One of the strategic advantages mentioned before was the cost efficiency. The capacity that previously was

loaded in a few trucks, easily could be transported by a single train, the bigger the transported cargo the smaller the cost per transported unit. This implies that an increase in demand will lead to a lower cost, but only when a significant enough number of companies will switch to rail mode.

Road transportation accounts for over 80% of exported goods. This share is incredibly big and very damaging for the environment. Investing and modernising the national railway network will increase the demand of its usage. An increase in train usage will eventually lead to a decrease of road transport which is the most polluting mode at the moment. The national railway network needs to be adapted to the standard gauge of 1520 mm, this will decrease the time spent by trains at the border and will make the connection to European rail corridors much simpler.

Another improvement would be construction of electrical lines, although this kind of project is planned, building the line won't be enough. An electrical rail line would be efficient only if there was at least one train to use it by the destination. Electrical lines can be used by both electrical and non-electrical trains. Only electrical ones are in need of those lines, alongside hybrid trains that could use the electricity from those railways, and save fuel for non-electrical segments of the rail road.

Switching from transporting the greatest exported categories using road transportation to rail mode will unlock a few strategic advantages for Moldova in foreign trade. One of the very important effects would be the long-term cost optimization, that would eventually reflect in a higher profitability.

Furthermore, the carbon emissions would decrease. Even if the Republic of Moldova doesn't have many big factories that populate and there is no pressure from outside to decrease the overall greenhouse gas emissions of the country, the responsibility for a sustainable economy is still there. Each nation, no matter the producing capacity, should treat the matter of the environment with high responsibility. Decreasing carbon print is one of the main objectives of European Mechanism of Integration.

European nations become more united during a crisis, but this is not what European integration is about. The Integration process means to unite people, simplify transitional processes without erasing one's nationality or ethnicity. Uniting multiple nations with historical conflicts between them was a hard mission from the very beginning, but "the future of the EU will depend on integrationist progress".[Techau, 2026] The integration applies not only to EU members but to the bordering countries as well. European Mechanism of Integrations focuses on:

- Durability
- Decarbonization
- The complementarity of transport modes
- The synergy between transportation, energy and digitalisation

The main objective of this mechanism is to create and develop a TransEuropean Network that would include: roads, railways, energy systems and other networks that connect European nations. This is a grandiose European project that will facilitate transnational European collaborations. It aims to modernise the existing transitional networks like railways, roads and electric systems. By developing its national railway network, alongside with its energetical one, Moldova is making another step toward European Integration.

The Republic of Moldova chose an European vector, it's a political decision and an economic one. For two decades the trade with the EU has been overshadowing the trade with eastern partners. The national railway network is not adapted to the modern economical needs of the country, but has a good potential for integration.

The resilience and process stability that rail mode offers exceeds the road transportation. The built railroads have a predefined trajectory, there is no deviation and the circulation on the rail is completely planned. This combination of factors lead to a high predictability. Trains tend to be on time, there are no delays caused by bad weather, unlike road transport.

Conclusions

The foreign trade of the Republic of Moldova is constantly growing. In 2025 the value of total import hit the 10 billion USD mark. During the past few years the export value has varied between 3 and 4

billion USD. The main strategic partners are EU countries. Half of both imports and exports are coming from or going to the EU member states. The geographical position of Moldova and its partners indicate towards terrestrial transport means. The main way of transport is the road mode, the most flexible one. The most sustainable, resilient and long-term cost efficient is the rail mode.

The railway transportation mode has a series of advantages. Its impact on the environment is less damaging when compared with road transport. The rail mode tends to be more stable, has less delays and the routes are very carefully planned. The load capacity is one of the key aspects, a big cargo assures a lower cost per transported unit.

Although these advantages are present, in the context of Moldovan railways, there are a series of improvements that ought to be done.

Transition to the standard gauge. This means that over 1200 km of railway lines have to be changed. A very costly process that will take time and maybe create discomfort in the rail industry for a while but it is worth it for the long-term efficiency. The Republic of Moldova had to implement the standard gauge and connect to the European rail corridors.

Electrification of the railways and introducing electrical or hybrid trains. On this day there is an approved project of electrification of a segment of Iasi-Ungheni rail line. However electrification of one segment is not enough, if there is no electrical or hybrid train to use it, the electrification of the line is pointless.

Connection to the European corridors. Following the transition to the standard gauge, connection to the European rail corridor expands the area of possible rail trade.

By implementing these three Moldova will integrate better with its European allies. These measures perfectly fit the European Mechanism of Integration, whose purpose is to facilitate cooperation between European nations, make it more energetically efficient and lower the greenhouse gas emissions. The Republic of Moldova proved numerous times its desire to cooperate with western partners, and its belonging to the European area. The echo of a soviet past still creates some impediments when it comes to European Integration. And the EU willingness to accept new members and help them integrate properly, is a crucial aspect of the integration process.

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COVID-19 AND THE ACCELERATION OF CROSS-BORDER ONLINE TRANSACTIONS: A COMPARISON BETWEEN THE REPUBLIC OF MOLDOVA AND EUROPE

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Abstract: *The COVID-19 pandemic profoundly transformed global commerce and consumer behaviour, acting as a catalyst for the rapid adoption of online trade and cross-border transactions. In response to lockdowns, mobility restrictions, and temporary closures of physical stores, both consumers and businesses increasingly relied on digital platforms to continue commercial activities. This study examines the impact of COVID-19 on cross-border e-commerce growth in the Republic of Moldova compared with the broader European context, while also exploring long-term post-pandemic trends and structural changes in digital payment systems. Using a combination of market reports, official statistics, and academic research, the analysis highlights the differences in adoption rates, technological infrastructure, and regulatory frameworks between these regions. In Moldova, rapid growth in e-commerce is observed, especially in mobile commerce and cross-border transactions, although challenges remain due to limited digital payment integration and lower overall market maturity. In contrast, European markets exhibited accelerated adoption of digital commerce on top of already well-developed infrastructures, with integrated cross-border payment systems and widespread consumer confidence in online platforms. The findings indicate that post-pandemic, online shopping habits are likely to remain elevated in both regions, with sustained growth driven by improved payment solutions, enhanced logistics, and increased digital literacy. Policy recommendations emphasize targeted investment in digital infrastructure, expanded adoption of electronic payments, and support for cross-border trade mechanisms to ensure long-term resilience and competitiveness in the e-commerce sector.*

Keywords: *cross-border e-commerce, COVID-19, online transactions, digital payments.*

JEL: L81, F14, O33, G21.

Introduction

The onset of the COVID-19 pandemic in early 2020 compelled economies across the globe to undergo an accelerated shift toward digital commerce, as traditional retail operations and in-person trade faced unprecedented interruptions. Lockdowns, social distancing measures, and temporary closures of physical stores limited conventional avenues for purchasing goods and services, thereby prompting both consumers and businesses to explore online alternatives. Within this context, cross-border e-commerce emerged as a crucial channel, enabling consumers to access a wider variety of products and services beyond their national markets. The pandemic-induced disruption acted as a catalyst for the adoption of digital payment systems, enhanced logistics solutions, and online retail platforms, thereby reshaping consumer behaviour and commercial practices. This rapid transformation is observable across different market environments, encompassing both emerging digital economies

such as the Republic of Moldova, where infrastructural and technological challenges coexist with strong growth potential, and more mature European digital markets, where well-established e-commerce ecosystems and integrated cross-border payment mechanisms facilitated swift adaptation. The comparison underscores the interplay between digital infrastructure, market maturity, and regulatory frameworks in shaping the pace and scale of cross-border online transactions during the pandemic.

Basic content

According to the State Globe Report, the e-commerce sector in the Republic of Moldova, which had previously been relatively underdeveloped, experienced notable growth during and following the COVID-19 pandemic. The period of economic disruption served as a turning point, triggering a substantial increase in online commercial activity. Overall sales through digital channels rose sharply, reflecting both a higher volume of transactions and broader adoption of e-commerce platforms and digital payment methods. Recent market assessments project that Republic of Moldova's cross-border e-commerce turnover could reach approximately \$320 million by 2026, underscoring the sector's rapid expansion. This growth is strongly supported by an estimated 78% adoption rate of digital payment solutions among consumers, indicating increased trust and comfort in conducting financial transactions online. Furthermore, mobile commerce plays a central role in this digital transformation, accounting for around 65% of all online transactions, highlighting the importance of mobile devices in facilitating access to cross-border goods and services. Collectively, these trends demonstrate a marked rise in consumer confidence, digital literacy, and engagement with online commerce since the pandemic, signaling a structural shift in shopping behavior and laying the groundwork for continued expansion of Republic of Moldova's e-commerce ecosystem in the coming years (State Globe, 2026).

Recent reports indicate that Republic of Moldova's e-commerce market experienced an impressive annual growth rate of approximately 15% in 2024, reflecting both heightened consumer engagement and a surge in digital commercial activity. Over the past two years, the number of online retail platforms has more than doubled, illustrating a rapid structural expansion within the sector that outpaces many global averages. This growth highlights the increasing entrepreneurial and technological investment in digital trade channels, as businesses adapt to evolving consumer preferences and the accelerated adoption of online shopping catalyzed by the COVID-19 pandemic. Nevertheless, despite this remarkable progress, Republic of Moldova's e-commerce ecosystem remains comparatively less digitalized than the European average. Traditional physical retail and in-person shopping continue to account for a significant portion of overall consumer expenditure, underscoring persistent reliance on conventional commerce channels. The coexistence of rapid digital expansion alongside enduring offline practices reflects a transitional phase in the Moldovan market, characterized by increasing digital adoption yet constrained by infrastructural, regulatory, and cultural factors. Understanding this duality is essential for policymakers, businesses, and financial institutions seeking to foster sustainable e-commerce growth, enhance digital payment integration, and promote cross-border online trade while addressing the structural limitations that continue to shape the pace of digital transformation in Republic of Moldova (Logos Press, 2025).

Furthermore, data indicate that consumers in the Republic of Moldova display a pronounced tendency to engage with foreign e-commerce platforms. In 2023 alone, spending on international online retailers exceeded €340 million, highlighting the increasing significance of cross-border purchasing behaviour. This trend reflects a shift in consumer habits that was accelerated by the COVID-19 pandemic, as restrictions on domestic shopping and limited availability of certain goods prompted buyers to seek products and services beyond national borders. The strong reliance on international platforms underscores both the growing familiarity of Moldovan consumers with online transactions and the critical role of digital infrastructure, such as secure payment methods and efficient logistics,

in facilitating cross-border commerce. It also signals the emergence of a more globally integrated consumer base, which is likely to influence market strategies for both domestic and foreign e-commerce providers. Overall, this development illustrates how the pandemic acted as a catalyst for early adoption of cross-border online shopping in Republic of Moldova, establishing foundational trends that continue to shape consumer behaviour, e-commerce growth, and digital engagement within the country (IPN Press Agency, 2024).

Across Europe, the COVID-19 pandemic acted as a powerful catalyst for the adoption and expansion of e-commerce, as lockdown measures, social distancing requirements, and temporary closures of physical retail outlets reshaped consumer purchasing patterns. During this period, a substantial proportion of European businesses either initiated online sales operations or accelerated the growth of existing digital channels, in order to maintain continuity of trade and respond to the sudden shift in consumer behaviour. Data from Eurostat highlight that in 2020, these adaptations were widespread, with many enterprises rapidly embracing e-commerce platforms, digital marketing strategies, and online customer engagement tools. This surge in online activity not only enabled firms to mitigate the economic impact of the pandemic but also contributed to the long-term transformation of retail ecosystems across the continent. The accelerated integration of digital sales channels into business models underscores a structural shift in commerce, emphasizing the growing importance of flexible, technology-driven approaches to meeting consumer demand. Moreover, the European experience demonstrates how digital infrastructure, regulatory frameworks, and logistical capacity collectively influenced the speed and scale of e-commerce adoption, setting the stage for sustained growth in cross-border transactions and online retail well beyond the pandemic period (Eurostat, 2022).

According to the European E-commerce Report 2025, the European e-commerce market has maintained a strong growth trajectory even after the acute phase of the COVID-19 pandemic. Specifically, total B2C e-commerce turnover rose from approximately €784 billion in 2023 to €842 billion in 2024, reflecting the resilience and continued expansion of online retail across the continent. This sustained increase indicates that consumer engagement with digital sales channels has persisted beyond pandemic-related restrictions, demonstrating the lasting structural impact of COVID-19 on shopping habits. The growth is underpinned by multiple factors, including widespread adoption of online payment solutions, improved logistics and delivery systems, and the ongoing digitalization of both established and emerging retailers. Moreover, the data suggest that European consumers have increasingly integrated online shopping into their regular purchasing patterns, while businesses have adapted by investing in digital platforms, omnichannel strategies, and cross-border sales capabilities. The continued expansion of e-commerce turnover across Europe underscores the sector's robustness and highlights its critical role in supporting economic recovery, promoting market competitiveness, and fostering greater access to goods and services in a post-pandemic landscape (European E-commerce Report 2025, 2025).

Cross-border e-commerce within Europe has also experienced substantial growth, reflecting the increasing interconnectedness of digital marketplaces across national boundaries. Recent reports indicate that European cross-border online platforms collectively generated approximately €326 billion in turnover during 2023–2024, highlighting the critical role of international e-commerce giants such as Amazon, AliExpress, and eBay in facilitating trade across the continent. This growth demonstrates that European consumers are increasingly willing to engage with foreign online retailers, motivated by a wider selection of products, competitive pricing, and convenience in delivery. The expansion of cross-border transactions also underscores the strategic importance of digital infrastructure, payment integration, and logistics networks in supporting seamless international commerce. Furthermore, the increasing reliance on these global platforms illustrates how e-commerce has become a central driver of regional economic activity, fostering both consumer access to diverse goods and opportunities for businesses to reach new markets. The post-pandemic period, in particular, has reinforced these trends, as restrictions on physical retail and heightened

consumer comfort with online shopping catalyzed enduring changes in purchasing behaviour. Overall, the European cross-border e-commerce market reflects a dynamic and resilient sector, emphasizing the growing prominence of international digital platforms in shaping trade flows and economic interactions within Europe (Cross-Border Commerce Europe, 2024).

Post-pandemic developments in the Republic of Moldova indicate that the e-commerce sector continues to gain momentum, driven by increasing digitisation, particularly in mobile commerce and digital payment adoption (State Globe, 2025; Reports on Moldovan E-commerce Market, 2024). The rapid growth of local online platforms, coupled with rising cross-border purchases, suggests that consumer behaviour shifts initiated during the COVID-19 pandemic have become enduring patterns. Despite these advances, Moldova's overall e-commerce penetration remains moderate relative to European averages, highlighting ongoing structural and infrastructural needs for further digital development (European E-commerce Report, 2025). Consumer preferences have notably evolved, with mobile devices now accounting for a majority of online traffic and transactions, reflecting a predominantly mobile-first user profile shaped by pandemic-induced digital adoption.

In Europe, although there has been a partial revival of physical retail, hybrid omnichannel approaches and digital enhancements continue to play a central role in retail strategies (Eurostat, 2020; European E-commerce Report, 2025). The e-commerce market maintains annual growth, supported by widespread internet access, improved digital payment technologies, and higher consumer confidence in online transactions, even as growth rates moderate relative to the peak pandemic period. Cross-border online shopping remains robust, with European consumers increasingly engaging with international platforms, signalling a long-term shift toward borderless digital commerce (European Cross-border E-commerce Data, 2023/2024). This expansion is facilitated by the ongoing evolution of secure digital payment systems and efficient logistics networks, ensuring seamless international transactions and reinforcing the strategic importance of cross-border e-commerce in the post-pandemic economic landscape.

In the Republic of Moldova, the adoption of digital payment solutions for e-commerce transactions has accelerated significantly since the onset of the COVID-19 pandemic. Merchants increasingly integrate online payment systems into their platforms, while consumers have gradually shifted from traditional cash-on-delivery methods to electronic payment options, reflecting an ongoing transformation toward a more digitally oriented economy (State Globe, 2025; Reports on Moldovan E-commerce Market, 2024). The growth in both the volume of digital transactions and the number of active payers signals structural changes within Moldova's commercial ecosystem, indicating that digital finance is becoming a central component of consumer behaviour. Nevertheless, challenges persist, as a substantial portion of transactions continues to rely on cash-based methods, highlighting the need for further investment in payment infrastructure and the promotion of financial digital literacy to ensure widespread adoption.

Across European markets, digital payments are highly integrated and diverse, encompassing instant payment systems, digital wallets, and open banking solutions, which collectively enhance the speed, security, and convenience of cross-border e-commerce (European E-commerce Report, 2025; Eurostat, 2020). Regulatory measures, such as the Payment Services Directive 2 (PSD2) and the Single Euro Payments Area (SEPA) framework, have further facilitated seamless and efficient financial transactions across national borders, supporting the growth of intra-European online trade. These structural and regulatory enhancements in the payment landscape have reinforced a resilient and sustainable digital commerce ecosystem, enabling businesses and consumers alike to engage in international transactions with greater confidence, efficiency, and security.

Table 1. COVID-19 and the Acceleration of Cross-Border Online Transactions: A Comparison Between the Republic of Moldova and Europe

Indicator	Republic of Moldova (2026 Projection)	Europe (2024/2025 Data)
Cross-Border E-commerce Turnover	~\$320 million total projected cross-border e-commerce transactions for 2026, showing rapid market expansion for a small economy (State Globe, 2025)	~€358.7 billion cross-border e-commerce turnover in 2024/2025, underscoring strong regional digital trade activity (Cross Border Commerce Europe, 2024).
Digital Payment Adoption	~78% of consumers expected to use digital payments in Moldova by 2026 (State Globe, 2025)	Digital payments widely integrated across European markets, supported by PSD2 and SEPA frameworks that ease cross-border transactions (European E-Commerce Report 2025,2025).
Mobile Commerce Share	65% of online transactions in Moldova projected to be made via mobile devices in 2026 (State Globe, 2025)	High mobile commerce penetration across many European markets, contributing significantly to overall online purchases.
E-commerce Growth Trend	Moldova's e-commerce market grew about 15% annually in 2024, with the number of online shops more than doubling in two years (Logos Press, 2025).	European B2C e-commerce continues to grow, with total turnover rising from €784 billion to €842 billion between 2023 and 2024 (European E-Commerce Report 2025,2025).
Relative Digitalisation	Still lagging behind Europe in overall e-commerce penetration and retail digitalisation (Logos Press, 2025).	Europe's e-commerce market is more mature, with a much larger digital retail footprint and cross-border market integration (European E-Commerce Report 2025,2025).

Source: State Globe, 2025; Cross Border Commerce Europe, 2024; Logos Press, 2025

Table 1. *COVID-19 and the Acceleration of Cross-Border Online Transactions: A Comparison Between the Republic of Moldova and Europe*, provides a detailed overview of the principal quantitative distinctions between the Republic of Moldova's developing cross-border e-commerce industry and the more established European digital market. It underscores the differential scale, adoption rates, and structural characteristics that define these two regions, offering a clear perspective on how the COVID-19 pandemic served as a catalyst for online commercial activity across both contexts. By comparing indicators such as transaction volumes, digital payment penetration, mobile commerce share, and annual growth rates, the table illustrates not only the accelerated uptake of e-commerce in response to pandemic restrictions but also the persistent disparities in digital infrastructure, consumer behaviour, and market maturity. In Republic of Moldova, emerging platforms and rising cross-border purchasing activity signal a rapidly evolving digital economy, whereas in Europe, high market saturation, integrated payment systems, and established cross-border marketplaces demonstrate sustained resilience and structural robustness. Overall, the table conveys how the pandemic-induced shift toward online trade has produced both converging trends, such as increased consumer engagement and reliance on mobile and digital payments, and divergent patterns reflecting varying degrees of market sophistication, readiness for digital commerce, and infrastructural development. By presenting these comparisons in a structured format, the table serves as a concise tool for understanding the broader implications of COVID-19 on e-commerce trajectories in transitional and mature markets alike.

Conclusions

The COVID-19 pandemic served as a powerful catalyst in accelerating the adoption and expansion of e-commerce and cross-border digital transactions, both in the Republic of Moldova and throughout Europe. The unprecedented disruptions caused by lockdowns, mobility restrictions, and the temporary shutdown of physical retail channels compelled consumers and businesses to rapidly transition toward digital solutions for trade and financial interactions. In the case of Republic of Moldova, although the online market remains relatively small and less developed in comparison to European standards, the sector has demonstrated robust growth dynamics. This progress is further supported by increasing integration with European payment systems and digital financial frameworks, which enhances interoperability and facilitates cross-border transactions, thereby indicating considerable long-term development potential.

Conversely, Europe's digital economy, characterized by its scale and maturity, is transitioning into a phase of post-pandemic stabilization. Rather than experiencing rapid expansion, the focus has shifted toward consolidation and optimization, with sustained reliance on online commerce channels, deeper penetration of digital payment technologies, and continuous structural improvements in financial and regulatory infrastructures. These developments reflect a more advanced stage of digital transformation, where innovation is directed toward efficiency, security, and cross-border integration. Overall, the impact of the pandemic extends beyond short-term adaptations, having fundamentally transformed consumer behaviour, accelerated the evolution of payment systems, and established a durable foundation for the ongoing growth and globalization of online commerce in both emerging and developed markets.

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FINANCIAL SECTOR DEVELOPMENT, MICROCREDIT, AND EXPORT PERFORMANCE OF SMALL FIRMS IN THE REPUBLIC OF MOLDOVA

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Abstract: *This article examines the relationship between financial sector development, access to microcredit, and the export performance of small firms in the Republic of Moldova. The study starts from the assumption that limited access to finance remains one of the main barriers preventing small enterprises from expanding production, improving quality, and entering foreign markets. The aim of the article is to assess whether a more developed financial sector can improve export capacity by facilitating microcredit and related financing instruments for small businesses. The analysis is based on secondary data, policy reports, academic literature, and firm-level evidence from the World Bank Enterprise Survey for Moldova (2024). The methodological approach combines descriptive and analytical discussion with a weighted firm-level empirical exercise testing whether access to external finance is associated with export participation. The empirical results provide only partial support for the main hypothesis. In the pooled sample, access to credit does not show a statistically significant positive effect on export participation after controls are included, while firm size remains the strongest predictor of exporting. At the same time, the results in the manufacturing subsample are more consistent with the expected positive relationship, although still statistically imprecise. The article concludes that financial sector development remains an important enabling factor for export performance, but its effect is conditional on firm scale, sector, and broader structural constraints.*

Key words: *financial sector development, microcredit, small firms, export performance, Republic of Moldova*

JEL: G21, F14, L25, O16

Introduction

Small firms play an important role in economic development through employment creation, income generation, innovation, and regional diversification. In small open economies such as the Republic of Moldova, their contribution is especially significant because they can support production flexibility, local entrepreneurship, and integration into external markets. At the same time, the export performance of small firms often remains below potential due to structural and financial constraints that limit their capacity to grow and compete internationally.

Among these constraints, access to finance is one of the most persistent barriers. Small firms usually face greater difficulties than large enterprises in obtaining external funding because they often lack sufficient collateral, stable credit history and the financial resources needed to absorb high borrowing costs. These limitations affect their ability to invest in equipment, improve productivity, adopt new technologies, ensure product quality, and finance working capital. As a result, many firms remain oriented toward the domestic market even when export opportunities exist.

In this context, financial sector development becomes highly relevant for SME internationalization. A more developed and inclusive financial system can improve the allocation of financial resources, expand lending opportunities, and reduce informational and institutional barriers between creditors and borrowers. One of the most important channels through which this process may operate is microcredit. For small firms, microcredit can serve as an accessible financing instrument that supports business expansion, production adjustment, and export readiness, especially in environments where traditional bank lending remains limited.

The relationship between finance and exports is particularly important in the Republic of Moldova. As a small economy exposed to external demand conditions, Moldova depends on export growth for broader economic development and competitiveness. However, the capacity of small firms to participate in foreign trade is still constrained by limited financing opportunities, modest institutional support, and uneven access to financial services. This makes the analysis of financial sector development and microcredit especially relevant from both an academic and a policy perspective.

The aim of this article is to examine the extent to which financial sector development influences the export performance of small firms in the Republic of Moldova through improved access to microcredit. The article assumes that better financial intermediation and broader access to small-scale financing can strengthen export capacity by enabling firms to invest, expand production, and meet the requirements of foreign markets. To complement the conceptual and descriptive analysis, the article also includes a firm-level empirical exercise based on the World Bank Enterprise Survey for Moldova (2024), testing whether access to external finance is associated with a higher likelihood of export participation. The empirical results provide only partial support for the main hypothesis: while the estimated relationship between finance and export participation is not statistically strong in the pooled sample, it is more consistent with the expected direction in manufacturing, and firm size emerges as the most robust predictor of exporting. This suggests that financial access matters, but its role is conditional rather than sufficient on its own. At the same time, the paper also considers the barriers that may reduce the effectiveness of this relationship, including borrowing costs, collateral requirements, and institutional weaknesses.

In Moldova-focused literature, the issues of SME finance, microfinance, and export competitiveness have already been examined, but mainly in separate analytical strands. Țurcanu (2023) analyses access to finance for SMEs from the Republic of Moldova in relation to competitiveness within global value chains, while Erhan and Paladi (2021) discuss traditional and alternative sources of SME financing. Sava, Țișu and Apetrii (2023) focus on microfinance organizations under conditions of crisis and uncertainty, and Stratan and Fala (2023) examine international competitiveness from a broader structural perspective. However, the specific relationship between financial sector development, access to microcredit, and the export performance of small firms in the Republic of Moldova remains insufficiently explored. This article seeks to address that gap by linking financial development to small-firm export capacity through the channel of microcredit.

The article is structured as follows. The next section discusses the conceptual relationship between financial sector development, microcredit, and export performance, with reference to the particular conditions of small firms in Moldova. The final section presents the main conclusions and highlights several policy implications for improving SME finance and export competitiveness.

Basic content

Small and medium-sized enterprises occupy a central place in the Moldovan economy and therefore matter directly for the country's production and export potential. According to the National Bureau of Statistics, in 2024 SMEs represented 99.2% of all reporting enterprises, employed 356.0 thousand persons or 65.5% of total enterprise employment, and generated 46.1% of total sales revenues. These figures show that any constraint affecting SME financing also has wider implications for national competitiveness and trade capacity (National Bureau of Statistics of the Republic of Moldova, 2025a).

The first relevant dimension is financial sector development. Recent data from the National Bank of Moldova indicate that the banking sector has continued to strengthen: in 2024 total banking assets reached MDL 170.2 billion, up 10.6% from the previous year, while the volume of new loans in national currency increased by 43.6%. The non-bank lending sector also expanded, with assets rising by 15.3% to MDL 18.8 billion. At the same time, the expansion of assets and lending has not fully removed long-standing constraints in SME access to finance, which remains a key challenge for productive investment and business expansion (National Bank of Moldova, 2025), and export performance inclusively.

These structural weaknesses are also visible at the firm level. The 2024 World Bank Enterprise Survey for Moldova shows that access to finance remains a significant business constraint: 10.6% of firms identified it as their biggest obstacle. The same survey indicates that firms still rely heavily on internal funding, with 84.0% of investment financed internally, while only 12.6% of investment was financed by banks and only 27.0% of firms reported using banks to finance investments. This pattern suggests that many small firms do not expand on the basis of external finance, but rather according to their limited internal liquidity, which slows modernization and reduces readiness for export activity (World Bank Enterprise Surveys, 2024).

In this context, microcredit becomes an important transmission channel between financial sector development and export performance. For small firms, access to relatively small and flexible loans may support the purchase of equipment, product upgrading, certification, packaging, digitalization, and working capital for export orders. This is particularly relevant in Moldova, where external competitiveness depends not only on production capacity but also on firms' ability to meet market standards and integrate into value chains. OECD situational reports on Moldova has explicitly linked SME development policy with internationalization and integration into global value chains, while the World Bank's MSME Competitiveness Project treats access to finance, export readiness, and business expansion as mutually reinforcing objectives. Beneficiary MSMEs are expected to use working-capital and investment lending for business expansion, technology adoption, and export activities (OECD, 2020; World Bank, 2026).

The export dimension makes this relationship even more important. Official trade statistics show that Moldova's goods exports amounted to USD 3.56 billion in 2024, and 67.3% of these exports went to the European Union. This orientation increases the need for financing because small firms entering EU markets must adjust production processes, improve quality, and manage liquidity under more demanding competitive conditions. In other words, export participation is not only a trade issue, but also a financing issue. Firms that cannot access affordable credit are less able to cover the fixed costs of market entry and less prepared to respond to foreign demand (National Bureau of Statistics of the Republic of Moldova, 2025b).

Recent policy initiatives confirm both the importance of SME finance and the persistence of financing gaps. In 2024, EIB Global and the Moldovan Commercial Bank MAIB signed a €50 million loan together with an EU-backed guarantee expected to mobilise an additional €44 million in loans to MSMEs on more favourable terms. In parallel, the World Bank reported in 2026 that 125 matching grants had already been approved for firms in export-oriented sectors, generating business missions and commercial contracts, although the uptake of the Credit Guarantee Fund remained slower than expected. This suggests that Moldova is moving toward a more supportive financial framework, but that institutional design and effective absorption remain just as important as the availability of funds itself (European Investment Bank, 2024; World Bank, 2026).

Overall, the evidence supports the argument that financial sector development can improve the export performance capacity of small firms mainly through easier access to microcredit and related financing instruments. However, the effect is not automatic. A stronger banking and non-bank financial sector creates the possibility of wider lending, but export gains depend on whether finance actually reaches small firms under conditions they can use. Where collateral barriers, borrowing costs, and informational asymmetries remain high, financial development may coexist with underfinanced SMEs and weak export participation. For Moldova, the central policy challenge is therefore not only to expand finance, but to make it more accessible, better targeted, and more compatible with the investment and liquidity needs of small exporting firms (National Bank of Moldova, 2025; World Bank Enterprise Surveys, 2024).

To complement the descriptive analysis, a firm-level empirical exercise was conducted using the World Bank Enterprise Survey for Moldova (2024). This survey covers 152 formal private establishments, was conducted between May and August 2024, and is based on stratified random

sampling with national coverage. In line with the World Bank methodology, the estimates were weighted using the survey's median sampling weights. Because the dataset is cross-sectional and does not isolate microcredit as a separate category, the estimates capture associations between external finance and export participation rather than strict causal effects of microcredit. The dependent variable was defined as an exporter dummy equal to 1 if direct or indirect exports accounted for at least 10% of total sales. Access to finance was approximated through whether the firm had a loan or line of credit and whether it had an overdraft facility, while firm size, age, foreign ownership, certification, and sector were included as controls. Given the modest sample size and the relatively low share of exporters, the most practical specification for the current aims of our paper is a **weighted linear probability model**, with weighted logit or probit used only as a robustness check. This is especially sensible because the Republic of Moldova 2024 profile reports that only **11.9%** of firms export directly at least 10% of sales and **12.4%** export directly or indirectly at least 10% of sales, while **27.0%** of firms use banks to finance investments and **10.6%** identify access to finance as their biggest obstacle. These descriptive patterns already suggest that the finance-export link is empirically relevant, even before estimation (World Bank Group, 2024; World Bank Enterprise Surveys, 2024). In the available data, export performance can be measured by an exporter dummy equal to 1 if the firm reports direct or indirect exports, using the trade variables for the share of direct exports and indirect exports in total sales. As a stricter robustness check, the dependent variable may be defined as 1 only for firms whose direct or indirect exports account for at least 10% of sales, which is also the threshold used in the World Bank country profile for Moldova. Access to microcredit cannot be observed as a separate variable in the dataset; therefore, the empirical analysis should approximate it through firm-level access to external finance, especially whether the firm has a loan or line of credit, an overdraft facility, the share of working capital financed by banks, the share of working capital financed by non-bank financial institutions, and the reported severity of access to finance as an obstacle. The weighted descriptive evidence confirms that exporting firms remain a relatively small share of the sample, consistent with the official country profile (World Bank Group, 2024).

In this regard, the empirical specification can be written as follows:

$$Export_i = \alpha + \beta_1 Credit_i + \beta_2 Overdraft_i + \gamma X_i + \varepsilon_i \quad (1)$$

where $Export_i$ is the export participation indicator, $Credit_i$ captures access to loans, credit lines, overdrafts, or bank-financed working capital, and X_i is a vector of control variables. Suitable controls available in the survey include firm size measured by employment, firm age derived from the year of formal registration, foreign ownership, top-manager experience, and internationally recognized quality certification.

The first-pass estimates provide only partial support for the article's main hypothesis. In the pooled sample, access to a loan or credit line does not show a statistically significant positive association with export participation after controls are added, while the overdraft variable is positive in sign but also statistically insignificant. By contrast, firm size has a consistently positive and statistically significant effect, suggesting that larger firms are substantially more likely to export. When the sample is restricted to manufacturing firms, the coefficient on credit access becomes positive, which is more consistent with the theoretical argument, although the estimate remains imprecise. Overall, the results suggest that access to external finance may support export activity, but in the Moldovan firm-level data its effect is weaker than the role of firm scale and structural characteristics. Therefore, the empirical findings should be interpreted as suggestive firm-level evidence consistent with the argument, though limited by sample size and cross-sectional data.

Table 1. Weighted estimates of export participation in the Republic of Moldova
Dependent variable: 1 if direct or indirect exports account for at least 10% of sales

Variable	Full sample (Credit access)	Full sample (Overdraft)	Manufacturing only (Credit access)
Credit access	-0.101 (p=0.120)		0.182 (p=0.303)
Overdraft		0.056 (p=0.581)	
Log employment	0.147 (p<0.001)	0.132 (p<0.001)	0.158 (p=0.009)
Firm age	-0.008 (p=0.078)	-0.008 (p=0.081)	0.002 (p=0.699)
Foreign ownership share	0.002 (p=0.028)	0.002 (p=0.145)	0.006 (p=0.006)
Quality certification	-0.081 (p=0.293)	-0.123 (p=0.170)	-0.160 (p=0.368)
Services sector	-0.181 (p=0.047)	-0.183 (p=0.041)	— —
Observations	146	143	73
R ²	0.254	0.242	0.321

Notes: 1) firms with an **overdraft facility** have a higher weighted export-participation rate than firms without one: **16.8% vs 11.3%**; 2) firms with a **loan or credit line** have a slightly higher weighted **any-export** rate: **19.1% vs 15.5%**. *Source:* Author's calculations based on World Bank Group (2024), www.enterprisesurveys.org

In light of our above calculations, we have reached to the point that the empirical estimates provide only limited support for the main hypothesis. In the full sample, access to a loan or credit line does not exhibit a statistically significant positive association with export participation once firm-level controls are introduced. Likewise, the coefficient on the overdraft variable is positive, but not statistically significant. By contrast, firm size appears as the strongest and most consistent determinant of exporting. In the manufacturing subsample, the coefficient on credit access becomes positive, which is more consistent with the theoretical expectations of the study, although the estimate remains statistically imprecise. Taken together, these findings suggest that access to external finance may facilitate export activity, but its effect is weaker than that of firm size and other structural characteristics. Thus, in the Moldovan context, financial access appears to function as a supportive rather than decisive factor in explaining export participation.

Conclusions

This article examined the relationship between financial sector development, access to microcredit, and the export performance of small firms in the Republic of Moldova. The analysis showed that small firms play an important role in the national economy, yet their export potential remains constrained by limited access to finance. In particular, insufficient external funding reduces their capacity to invest in production, improve quality, comply with foreign market requirements, and finance the working capital needed for export activity.

The study combined descriptive analysis with a firm-level empirical exercise based on the World Bank Enterprise Survey for Moldova (2024). The empirical results provide partial rather than

definitive support for the main hypothesis. In the pooled sample, access to a loan or credit line and overdraft facilities does not produce a statistically significant positive effect on export participation once firm characteristics are controlled for. However, the coefficients are more consistent with the expected positive relationship in manufacturing, while firm size remains the strongest and most robust predictor of exporting. These findings suggest that external finance may facilitate export activity, but its effect is conditional and appears weaker than the role of firm scale and other structural characteristics in the Moldovan context. In this sense, microcredit should be viewed not only as a tool for business survival, but also as a mechanism that can support competitiveness and internationalization. Overall, the article supports the view that financial sector development can contribute positively to export performance when it improves access to microcredit and related financing instruments adapted to the needs of small firms. At the same time, the results show that the benefits of financial development are not automatic. Where collateral requirements are high, borrowing costs are restrictive, and institutional support is insufficient, finance alone is unlikely to generate strong export expansion. In the case of the Republic of Moldova, improving access to finance for small firms should therefore be treated as part of a broader export development strategy, combined with measures that address firm capabilities, market readiness, and structural barriers. Better-targeted microcredit, stronger support institutions, and a more accessible financial environment could help increase the export participation and competitiveness of small enterprises. Therefore, the expansion of the financial sector must be accompanied by policies aimed at improving financial inclusion, diversifying SME lending instruments, strengthening guarantee mechanisms, and reducing barriers that prevent small firms from using credit productively. Thus, financial development should be understood as a relevant enabling factor for export competitiveness, although not a sufficient condition on its own.

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STRENGTHENING THE RESILIENCE OF UKRAINE'S FOOD INDUSTRY IN THE CONTEXT OF WAR, GLOBAL RISKS AND EUROPEAN INTEGRATION

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Abstract: *The article examines the resilience of Ukraine's food industry under the combined influence of full-scale war, global risks and European integration challenges. The purpose of the study is to identify the key factors that affect the stability of the national food industry and to substantiate strategic directions for strengthening its adaptive capacity in wartime and post-war recovery. The research is based on a systemic and analytical approach, combining the assessment of institutional, logistical, economic, environmental and regulatory challenges with the analysis of long-term development priorities for the food sector. Special attention is paid to disruptions in supply chains, loss of production capacities, rising production costs, labour shortages, export constraints, environmental risks and the need to harmonize Ukrainian food policy with European standards. The findings indicate that the resilience of the food industry depends on the development of local food systems, diversification of logistics, support for processing capacities, implementation of food safety and quality standards, digital transformation and stronger institutional coordination. The article argues that European integration should be considered not only as a regulatory obligation, but also as a framework for modernization, innovation and long-term competitiveness of Ukraine's food industry. The practical value of the research lies in outlining policy-oriented measures that may support recovery planning and enterprise-level adaptation.*

Keywords: *food industry; resilience; food security; war risks; European integration; Ukraine.*

JEL: L66, Q18, O13, F15, H56.

Introduction

The food industry occupies a strategic place in the national economy of Ukraine. It ensures the processing of agricultural raw materials, creates added value, supports employment, forms a significant part of regional economic activity and directly affects the level of food security. In normal economic conditions, the development of the food industry is associated with technological modernization, investment activity, expansion of domestic and foreign markets, improvement of product quality and strengthening of competitiveness. However, in the conditions of full-scale war, the role of the food industry becomes much broader. It turns into one of the critical elements of national resilience, because the stable functioning of food production, processing, storage and distribution is directly connected with the ability of the state and communities to provide the population with safe, affordable and sufficient food.

The full-scale military aggression of the Russian Federation against Ukraine has significantly changed the conditions for the functioning of the national food system. Enterprises of the food industry faced destruction of production facilities, disruption of logistics, loss of access to raw materials, energy instability, shortage of labour resources, growth of production costs, environmental damage and uncertainty in export markets. These challenges affected both large enterprises integrated into national and global supply chains and small and medium-sized producers that are important for local food systems. At the same time, the war demonstrated the importance of flexibility, territorial diversification and the ability of the food sector to adapt to crisis conditions (FAO, 2021; World Bank, 2024).

The relevance of this research is also determined by the global context. Food systems around the world are increasingly affected by climate change, energy instability, volatility of international markets, changes in consumer behaviour, pandemic consequences, geopolitical conflicts and increasing requirements for food safety and environmental sustainability. For Ukraine, these global risks are combined with the direct consequences of war and the need to deepen European integration. Therefore, the issue of strengthening the resilience of the food industry should be considered not only as a short-term anti-crisis task, but also as a strategic direction of national economic development.

European integration creates both new opportunities and new requirements for Ukraine's food industry. Approximation to European Union standards opens access to broader markets, improves the quality and safety of food products and stimulates institutional modernization. At the same time, compliance with European requirements requires significant investments, organizational changes, improvement of regulatory mechanisms and adaptation of enterprises to stricter standards. For many Ukrainian producers, especially small and medium-sized enterprises, this process may be difficult without targeted state support and international technical assistance.

The purpose of this article is to identify the main wartime and global risks affecting Ukraine's food industry and to substantiate strategic directions for strengthening its resilience in the context of European integration. The research objectives are to clarify the role of resilience in the development of food systems, analyse the main groups of risks for Ukraine's food industry, determine the importance of European integration as a modernization framework and propose priority directions for strengthening the adaptive capacity of the sector.

The methodological basis of the study is a systemic approach to the analysis of the food industry as a complex socio-economic and institutional system. The research also uses methods of generalization, comparative analysis, logical analysis and synthesis of scientific, analytical and regulatory materials related to food security, industrial development, wartime recovery and European integration.

Theoretical background: resilience of food systems and food industry. The concept of resilience has become increasingly important in the analysis of economic systems, food security and industrial development. In general terms, resilience means the ability of a system to withstand shocks, adapt to changing conditions and continue to perform its basic functions. For food systems, resilience is primarily associated with the ability to ensure stable access to food, maintain production and distribution chains, preserve the quality and safety of products and adapt to economic, environmental, political and social changes.

The food industry is an important component of food system resilience because it connects agricultural production with final consumption. It transforms raw materials into food products, provides storage and processing, forms added value and supports the stability of food supply. If the food industry is weak, fragmented or excessively dependent on vulnerable logistics and energy systems, the entire food system becomes more sensitive to shocks. Conversely, a technologically developed, regionally balanced and institutionally supported food industry can increase the resilience of the national economy and reduce the risks of food insecurity. The conceptual framework for optimizing the development of the food industry highlights this role in the broader context of implementing the national economic strategy (Sychevskyi et al., 2025).

In the context of Ukraine, the resilience of the food industry should be considered at several levels. At the national level, it concerns the ability of the country to ensure food security, maintain processing capacities, support exports and prevent excessive dependence on imports. At the regional level, resilience is associated with the ability of territorial communities and regions to provide basic food needs, preserve local production chains and support employment. At the enterprise level, resilience means the ability of producers to adapt to interruptions in raw material supply, energy shortages, changes in demand, labour shortages, price volatility and regulatory changes.

An important element of resilience is adaptability. The food industry must not only return to its previous state after a shock, but also transform in accordance with new conditions. In this sense,

resilience is closely related to modernization. The goal should not be the mechanical restoration of pre-war production models, but the creation of a more flexible, innovative and competitive food industry. This includes technological renewal, digitalization, energy efficiency, development of local food systems, strengthening of quality and safety standards, improvement of logistics and expansion of cooperation between the state, business, science and international partners.

The resilience of food systems is also connected with sustainability. A food industry that ignores environmental limits, resource efficiency and social responsibility cannot be considered resilient in the long term. Therefore, resilience should include economic, social, environmental and institutional dimensions. Economically, the food industry must remain competitive and financially viable. Socially, it must contribute to employment, food availability and regional development. Environmentally, it must reduce waste, use resources efficiently and respond to climate-related challenges. Institutionally, it must operate within a clear regulatory framework and be supported by effective public policy.

For Ukraine, this multidimensional understanding is especially important because the country is simultaneously solving several strategic tasks: maintaining food security during the war, restoring destroyed and damaged capacities, preserving export potential, adapting to European standards and preparing for post-war reconstruction. These tasks cannot be separated from each other. Strengthening resilience means building a food industry that is able to function under crisis conditions and at the same time move towards European integration and long-term competitiveness.

Wartime and global risks for Ukraine's food industry. The full-scale war created a complex system of risks for Ukraine's food industry. These risks are not isolated. They interact with each other and often create cumulative effects. For example, damage to infrastructure increases logistics costs, logistics problems affect access to raw materials, energy instability increases production costs, and all these factors together reduce competitiveness and investment attractiveness.

One of the most important groups of risks is related to the destruction and damage of production capacities. Food enterprises located in regions affected by hostilities have faced direct physical damage, loss of equipment, interruption of production processes and difficulties in maintaining labour collectives. In some cases, enterprises were forced to suspend their activities or relocate to safer regions. Such processes changed the regional structure of food production and created additional pressure on enterprises that continued to operate (Deineko et al., 2025).

Logistical disruptions have become another critical challenge. Before the full-scale invasion, a significant part of Ukrainian exports depended on seaports and established transport corridors. The blockade and insecurity of maritime routes, destruction of transport infrastructure, congestion at border crossings and the need to reorient export flows to alternative routes significantly complicated the movement of raw materials and finished products. For the food industry, this meant higher transport costs, longer delivery times, uncertainty in export contracts and a decrease in profitability (Rybak, 2025).

The raw material base of the food industry was also affected. Agricultural production suffered from occupation of territories, mining of agricultural land, destruction of farms, shortage of fuel and fertilizers, disruption of seasonal field works and environmental damage. As the food industry depends on a stable supply of agricultural raw materials, any reduction in the volume or quality of such raw materials directly affects processing enterprises. This is especially relevant for grain processing, oil and fat production, dairy processing, meat processing, fruit and vegetable processing and other sectors. According to available data, the food industry maintained its position as one of the key manufacturing sectors despite these wartime disruptions (State Statistics Service of Ukraine, 2021–2024).

Energy risks have become particularly significant. Attacks on energy infrastructure and the general instability of energy supply increased the vulnerability of food enterprises. Many technological processes in the food industry require continuous energy supply, refrigeration, heating, water

treatment and strict sanitary conditions. Interruptions in electricity supply can lead not only to economic losses, but also to deterioration of product quality and safety risks. Therefore, energy autonomy and energy efficiency have become important components of enterprise resilience.

Another important challenge is the increase in production costs. The war led to higher prices for energy, fuel, raw materials, packaging, logistics and imported equipment. Currency fluctuations and inflationary pressure also affected the cost structure of enterprises. As a result, producers faced the difficult task of maintaining affordable prices for consumers while preserving financial viability. This is especially important because food products belong to basic goods, and excessive price growth can deepen social vulnerability.

Labour shortages also affect the food industry. Mobilization, internal displacement, migration abroad and changes in the structure of regional labour markets reduced the availability of qualified personnel. Enterprises faced difficulties in finding workers, technologists, engineers, logistics specialists and managers. The shortage of human capital may slow down modernization, reduce productivity and complicate the introduction of new quality and safety standards.

Environmental risks caused by the war have long-term consequences for the food industry. Pollution of land and water resources, destruction of irrigation systems, damage to ecosystems, mining of territories and contamination with explosive remnants of war can affect the quality of raw materials and the safety of food products. These risks require systematic monitoring, environmental restoration and integration of environmental safety into food industry development strategies.

Global risks also remain relevant. Climate change affects agricultural productivity, water availability and the stability of raw material supply. Volatility in global food markets affects prices and export opportunities. Geopolitical tensions influence trade routes and access to international markets. At the same time, consumer demand is changing in favour of safer, healthier, more sustainable and traceable food products. Therefore, Ukrainian food enterprises must adapt not only to wartime challenges, but also to global transformations of food markets.

The combination of wartime and global risks demonstrates that the resilience of Ukraine's food industry cannot be strengthened by one isolated measure. It requires a comprehensive policy that includes support for enterprises, restoration of infrastructure, development of logistics, energy security, access to finance, innovation, quality management and integration into European markets.

European integration as a framework for modernization. European integration is one of the key strategic directions for Ukraine's development. For the food industry, this process has a special meaning because access to the European market depends on compliance with strict requirements for food safety, quality, traceability, environmental standards and consumer protection. International organizations have emphasized that comprehensive reforms in agricultural and food policy are essential for Ukraine's long-term competitiveness and sustainable EU alignment (OECD, 2022). Therefore, European integration is not only a political or trade process, but also a deep institutional and technological transformation of the food sector.

The harmonization of Ukrainian legislation with European Union standards creates a framework for improving the quality and safety of food products. The implementation of HACCP principles, sanitary and phytosanitary measures, traceability systems and modern control procedures is essential for increasing consumer confidence and expanding export opportunities. In the long term, this can strengthen the competitiveness of Ukrainian producers both in domestic and foreign markets (European Commission, 2023).

However, compliance with European standards requires significant efforts from enterprises. Large companies usually have more resources to implement quality management systems, modernize equipment and meet certification requirements. Small and medium-sized enterprises often face financial, organizational and informational barriers. Therefore, state policy should include targeted support mechanisms for SMEs, advisory services, training programs, simplified access to information and financial instruments for modernization.

European integration can also stimulate technological renewal of the food industry. Modern European approaches emphasize resource efficiency, reduction of food losses and waste, circular economy, energy efficiency, environmental responsibility and digital traceability. These directions are fully consistent with the need to build a more resilient food industry in Ukraine. For example, the development of circular models can help reduce dependence on primary resources, use by-products more efficiently and create additional value.

An important aspect of European integration is the development of institutional capacity. Effective food policy requires coordination between ministries, regional authorities, regulatory bodies, business associations, scientific institutions and international partners. Weak institutional coordination can slow down reforms and create uncertainty for enterprises. Therefore, the modernization of the food industry should be supported by clear strategic documents, transparent regulatory procedures, reliable monitoring and evidence-based decision-making.

European integration also creates opportunities for expanding export potential. Ukraine has strong agricultural and food production capacities, but the structure of exports still needs improvement. The development of processing and the production of goods with higher added value should become a strategic priority. Exporting raw materials alone does not fully use the economic potential of the country. Strengthening the processing sector can increase revenues, create jobs, support regional development and reduce vulnerability to price fluctuations in raw commodity markets.

At the same time, integration into the European market increases competition. Ukrainian producers will have to compete not only by price, but also by quality, reliability, sustainability, innovation and brand reputation. This requires a shift from survival strategies to development strategies. Even under wartime conditions, it is important to prepare the food industry for post-war competition, modernization and integration into European value chains.

Therefore, European integration should be considered as a modernization framework for strengthening resilience. It helps define the direction of reforms, improves regulatory standards, opens access to markets and stimulates innovation. However, to turn these opportunities into real results, Ukraine needs a balanced policy that combines regulatory approximation with practical support for enterprises.

Strategic directions for strengthening the resilience of Ukraine's food industry. Strengthening the resilience of Ukraine's food industry requires a set of strategic measures aimed at reducing vulnerabilities and increasing adaptive capacity. These measures should combine short-term crisis response with long-term modernization priorities outlined in national strategies (Cabinet of Ministers of Ukraine, 2021; Ministry of Agrarian Policy and Food of Ukraine, 2024). The key risks and relevant resilience measures are summarized in Table 1.

Table 1. Main risks and resilience measures for Ukraine's food industry

Risk group	Main manifestations	Priority resilience measures
Logistical risks	Blocked or overloaded transport corridors; increased delivery time and costs; uncertainty of export routes.	Diversification of logistics; development of multimodal routes; modernization of storage and border infrastructure.
Production capacity risks	Damage or loss of enterprises, equipment and warehouses; forced relocation; interruption of production cycles.	Investment support; reconstruction of damaged facilities; regional diversification of processing capacities.
Raw material risks	Loss of agricultural land; mining and environmental contamination; shortages of fuel, fertilizers and inputs.	Support for agricultural producers; demining and land restoration; stable contracts between farmers and processors.
Energy risks	Power outages; higher energy prices; risks for refrigeration, heating and sanitary processes.	Energy efficiency; backup power systems; renewable energy solutions; modernization of equipment.

Risk group	Main manifestations	Priority resilience measures
Labour and skills risks	Mobilization, migration and shortage of qualified personnel; lack of technologists and engineers.	Professional training; cooperation with universities; support for displaced specialists; upskilling programs.
Regulatory and market risks	Need to comply with EU standards; limited resources for certification; growing competition.	Consulting support for SMEs; HACCP implementation; access to finance; integration into European value chains.
Environmental risks	Pollution of soils and water; destruction of irrigation systems; risks for food safety and raw material quality.	Environmental monitoring; remediation; waste management; climate-smart and resource-efficient technologies.

Source: developed by the author based on the synthesis of wartime food industry risks and resilience policy approaches.

The first direction is the development of local and regional food systems. The war demonstrated that excessive dependence on centralized supply chains can create serious risks in crisis conditions. Local food systems can provide communities with basic food products, support small producers, reduce logistics dependence and increase territorial resilience. This does not mean isolation from national and global markets. Rather, it means creating a balanced system in which national, regional and local levels complement each other.

The second direction is diversification and modernization of logistics. Food industry enterprises need reliable access to raw materials, packaging, equipment and sales markets. Therefore, the restoration and development of transport infrastructure, border capacity, storage facilities, refrigeration chains and multimodal logistics are essential. Special attention should be paid to export routes, because food industry products with higher added value require stable and predictable logistics.

The third direction is support for processing capacities. The development of deep processing of agricultural raw materials should become one of the foundations of post-war recovery. Processing increases added value, creates jobs, strengthens regional economies and reduces dependence on raw commodity exports. Support instruments may include concessional loans, grants, tax incentives, investment guarantees and public-private partnerships.

The fourth direction is energy resilience. Food enterprises need stable energy supply, especially those that depend on refrigeration, drying, heat treatment and continuous technological processes. Energy efficiency programs, renewable energy sources, backup power systems and modernization of equipment can reduce vulnerability to energy shocks. In the long term, energy resilience also contributes to environmental sustainability and lower production costs.

The fifth direction is implementation of food safety and quality standards. Compliance with HACCP and European requirements should be supported not only through control, but also through education, consulting and financial assistance. It is important to help small and medium-sized enterprises adapt to modern standards, because they play a significant role in local food systems and regional development.

The sixth direction is digital transformation. Digital tools can improve traceability, logistics planning, resource management, risk monitoring and interaction between producers, suppliers, regulators and consumers. Digitalization can also increase transparency and support integration into European value chains. However, digital transformation requires investment in skills, infrastructure and cybersecurity.

The seventh direction is strengthening human capital. The food industry needs qualified workers, engineers, technologists, managers and specialists in quality control, logistics, export operations and digital systems. Training programs, cooperation with universities and research institutions, professional education and support for displaced specialists can help solve labour market challenges. The eighth direction is institutional coordination. The resilience of the food industry cannot be ensured only by enterprises. It depends on public policy, regulation, regional development strategies,

international assistance and scientific support. Therefore, Ukraine needs a coherent system of strategic planning, monitoring of risks and coordination between stakeholders. Scientific institutions can play an important role in providing analytical support, developing methodologies, assessing risks and preparing policy recommendations.

The ninth direction is environmental restoration and sustainability. The food industry depends on the quality of land, water, ecosystems and agricultural raw materials. Therefore, post-war recovery should include environmental monitoring, remediation of polluted territories, restoration of irrigation systems, waste management and support for environmentally friendly technologies. This is also important for compliance with European sustainability requirements.

The tenth direction is international cooperation. Ukraine needs continued support from international organizations, donor institutions, European partners and research networks. Such cooperation can provide financial resources, technical assistance, access to best practices and integration into international innovation systems. However, international support should be connected with national priorities and long-term development strategies.

These strategic directions are interconnected. Support for processing capacities requires energy resilience, logistics, investment and skilled personnel. European standards require institutional capacity, training and modernization. Local food systems depend on regional infrastructure, small producers and access to finance. Therefore, resilience policy should be systemic and coordinated.

Conclusions

The resilience of Ukraine's food industry has become one of the key conditions for maintaining food security, supporting economic stability and ensuring post-war recovery. The full-scale war has exposed the vulnerabilities of the national food system, including dependence on critical infrastructure, logistics disruptions, loss of production capacities, energy instability, raw material risks, labour shortages and environmental damage. At the same time, the food industry has demonstrated significant adaptive capacity and remains one of the strategic sectors of the Ukrainian economy.

The study shows that resilience should not be understood only as the ability to survive shocks. In the context of Ukraine, resilience also means the ability to transform, modernize and integrate into the European economic and regulatory space. Therefore, strengthening the resilience of the food industry should combine crisis response measures with long-term development priorities.

European integration plays a dual role in this process. It creates additional requirements for Ukrainian producers, especially in the fields of food safety, quality, traceability and environmental standards. However, it also provides a modernization framework, opens access to markets and encourages technological renewal. For this reason, European integration should be used as an instrument for strengthening competitiveness and institutional development.

The main strategic directions for strengthening resilience include the development of local food systems, diversification of logistics, support for processing capacities, improvement of energy resilience, implementation of European food safety standards, digital transformation, development of human capital, institutional coordination, environmental restoration and international cooperation. These directions should be integrated into national and regional strategies for food industry development.

A limitation of this study is that it is mainly based on general analytical assessment and synthesis of existing materials. Further research should include more detailed quantitative analysis of regional differences, enterprise-level resilience indicators and the effectiveness of specific support instruments. Ongoing research at the Institute of Food Resources of NAAS provides an important analytical foundation for these strategic decisions (Institute of Food Resources of NAAS, 2021–2025). It would also be useful to develop a practical methodology for assessing the resilience of food industry enterprises under wartime and post-war conditions.

In general, the future of Ukraine's food industry depends on the ability to transform wartime adaptation into a long-term modernization strategy. A resilient food industry can become one of the foundations of national economic recovery, regional development, food security and Ukraine's successful integration into the European economic space.

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HOUSING MARKET ILLIQUIDITY AND MORTGAGE DEEPENING IN MOLDOVA: THE ROLE OF SUBSIDIZED CREDIT AND TRANSACTION FORMALIZATION

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Abstract: *This paper examines the recent divergence in Moldova between falling real estate transaction volumes and continued mortgage lending growth. In standard housing market frameworks, transaction activity and credit tend to move together. However, recent data point to a different pattern: a sharp drop in market turnover alongside a steady increase in mortgage lending and its share of transactions. The paper seeks to explain this development by focusing on the structural and institutional changes. Rather than indicating a breakdown of conventional housing dynamics, the pattern points to a shift in who can participate in the market and how transactions are financed. Three main factors appear to be driving this change. First, rising housing prices have made it increasingly difficult for households to rely on their own funds. Second, government-supported mortgage programs have expanded access to credit for certain groups of borrowers. Third, the gradual formalization of transactions, particularly through tighter restrictions on cash payments, has raised the barriers to entry for buyers who depend on informal or non-documented sources of funds. Using descriptive evidence, the analysis shows that declining market activity reflects reduced participation rather than falling underlying demand. Mortgage lending continues to expand within a smaller pool of credit-eligible buyers, leading to a higher observed mortgage share. These data indicate that mortgage growth should not be read in isolation as a sign of a strong housing market. More broadly, the Moldovan case highlights how affordability constraints, credit policies, and increasing financial formalization can reshape housing market outcomes in emerging and transition economies.*

Key words: *housing market, transaction formalization, subsidized credit, mortgage*

JEL: O18, R30, R38

Introduction

Housing market patterns are generally characterized by a close relationship between transaction activity and credit conditions. (Arestis, 2014) In standard frameworks, periods of strong housing demand are associated with rising transaction volumes, increasing house prices, and expanding mortgage lending, while downturns tend to involve simultaneous declines in turnover and credit growth. This co-movement is well documented in the literature on housing cycles and credit dynamics (La Cava, G., 2016) and reflects the central role of mortgage finance in sustaining housing demand and market liquidity. (Meen, 2000)

Recent developments in Moldova's residential real estate market, however, deviate from this conventional pattern. Data from the National Bank of Moldova indicate that the number of real estate transactions declined significantly in recent quarters, by approximately 20% in Q4, showing a contraction in market turnover. At the same time, both newly issued mortgage loans and the share of transactions financed through mortgages increased markedly, with credit-backed purchases accounting for a growing majority of total sales in 2025. This divergence between falling transaction volumes and rising mortgage intensity appears paradoxical from the perspective of standard housing-market theory. (Guren, 2021)

This paper argues that the paradox does not reflect a broad-based expansion in housing demand, but rather a structural shift in the composition of market participants and financing mechanisms. In effect,

Moldova's housing market is becoming smaller in terms of total transactions, yet more dependent on bank-intermediated credit. This transformation is driven by three mutually reinforcing factors.

First, the expansion of government-supported mortgage programs, most notably Prima Casă Plus, has improved access to credit for selected segments of the population, sustaining mortgage demand even as overall market activity weakens. Similar effects of state-backed mortgage schemes on housing credit have been documented in other emerging European economies. (IMF, 2018)

Second, rising housing prices have eroded affordability for cash buyers and lower-income households, contributing to their partial withdrawal from the market. This has increased the relative weight of mortgage-dependent buyers, consistent with broader evidence on the interaction between affordability constraints and access to credit (Biljanovska, 2023).

Third, recent regulatory changes have accelerated the formalization of real estate transactions. In particular, Law No. 34/2024 on cash payments introduced stricter limits on cash transactions and requires high-value real estate purchases to be executed through bank transfers. While designed to enhance financial transparency and reduce the use of undeclared funds, this reform channels transactions into the formal financial system. As a result, buyers unable to comply with these requirements may face greater barriers to participation, potentially reducing market liquidity even as regulatory oversight improves.

Stricter income verification and source-of-funds requirements may also have reshaped financing behavior. Rather than fully excluding liquidity-constrained households, these constraints may encourage substitution toward informal or non-bank financing arrangements, such as family transfers, remittances, or informal borrowing. (Hamouri, 2020) Such mechanisms remain largely unobserved in official mortgage statistics, but they are important for understanding how households adjust to tighter formal requirements.

Taken together, these developments suggest that the Moldovan case does not represent a contradiction between declining market activity and expanding credit. Instead, it reflects a process of credit deepening under conditions of reduced turnover, driven by compositional shifts in demand and institutional changes in how transactions are financed and recorded.

Against this background, the aim of this paper is to examine why mortgage lending has continued to expand despite a decline in residential real estate transactions in Moldova. The study focuses on the role of government-supported mortgage programs, affordability constraints, and regulatory formalization in reshaping both the structure of demand and the financing of housing purchases. By doing so, it contributes to the broader literature on housing and credit cycles by showing how credit deepening can occur alongside contracting market activity, particularly in transition economies where financial development, public policy, and market formalization interact in ways not fully captured by standard housing-market models.

Institutional Background: Housing Finance and Transaction Formalization in Moldova

Moldova's residential real estate market has undergone a considerable transformation over the past decade, determined by financial deepening, macroeconomic stabilization, and institutional development. Historically, the market relied heavily on cash transactions, while access to mortgage financing remained limited, and informal practices played a non-negligible role in housing purchases. In recent years, however, bank-intermediated credit has become increasingly important, supported by rising household incomes and targeted policy measures to expand access to housing finance.

More recently, this structure has shifted. Mortgage lending is now more visible in housing finance. Higher household incomes, deeper banking-sector intermediation, and policies to improve access to home ownership support this growth. Government-backed programs like Prima Casă and Prima Casă Plus are important. By partly guaranteeing loans, these schemes reduce bank risk and make borrowing easier for households who might struggle to qualify for standard products. As a result, formal credit

has become a key route into the housing market, especially for first-time buyers and middle-income households.

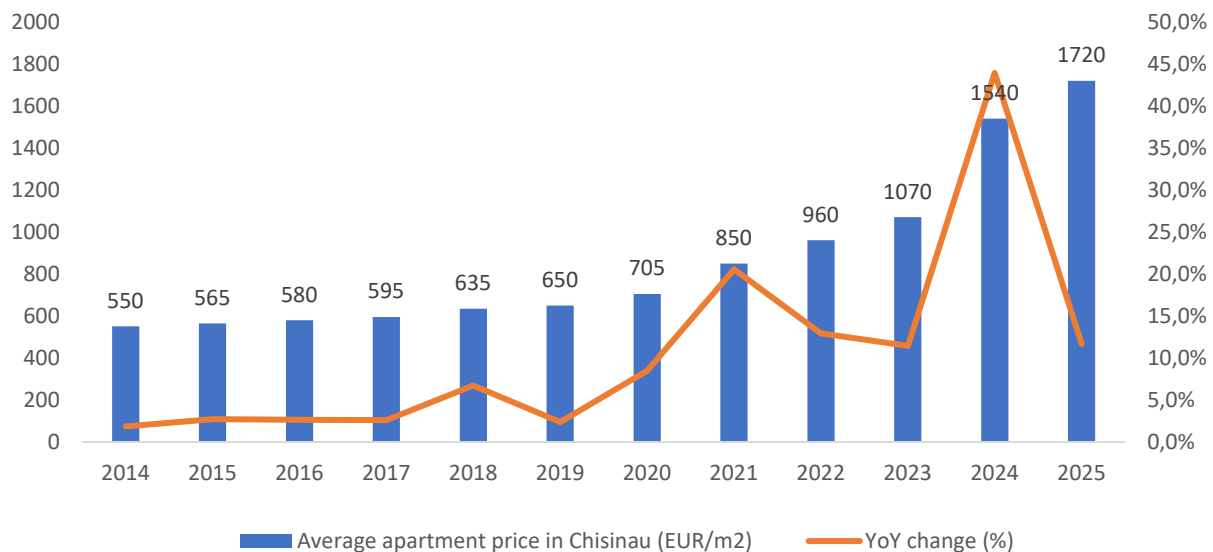


Figure 1. Average apartment price in Chisinau (EUR/m²)

Source: Acces Imobil

This expansion of credit has changed market participation. Housing purchases are increasingly concentrated among households that can meet formal borrowing requirements. Those who depend on savings or informal income face more barriers to entry. These compositional changes closely match developments in house prices. Average apartment prices in Chişinău have increased over the past fifteen years. The increase followed a two-stage path: relative stagnation after the global financial crisis, then a marked acceleration after 2019. By 2023, prices reached about €1,500 per square meter, signaling significant real appreciation.

Rising prices have weakened affordability, especially for lower- and middle-income households, because property values are increasing faster than incomes. As a result, entering the market costs more for buyers who rely on savings rather than credit. For households with irregular incomes or reduced access to formal financing, this dynamic limits their ability to buy, thereby constraining demand. Importantly, this does not mean underlying housing demand is falling; rather, it reveals a widening gap between desired and effective demand. Preferences for homeownership remain strong, but more households cannot meet the financial conditions needed to participate in the formal housing market.

This progressing interaction between mortgage expansion, rising prices, and affordability pressures provides an important backdrop to understand the divergence between declining transaction volumes and increasing mortgage activity examined in this paper.

The consequences for market structure are direct. As affordability deteriorates, participation becomes increasingly concentrated among households with access to formal credit, either through conventional mortgage products or government-supported schemes, such as Prima Casă Plus. At the same time, the pool of cash-capable buyers contracts, reducing the diversity of financing channels within the market. This means that rising prices do not simply make housing more expensive; they also reshape who can participate in the market and through which financial instruments transactions can take place. This affordability channel is important because it operates independently of recent regulatory changes. Even in the absence of stricter transaction formalization requirements, rising prices alone would be expected to reduce transaction volumes while increasing the relative share of mortgage-financed purchases. As fewer households are able to purchase property outright, those who remain active in the market are more likely to rely on bank credit. In practice, however, affordability pressures and regulatory formalization reinforce one another. Higher prices exclude liquidity-constrained households,

while stricter payment and verification requirements further reduce participation among buyers unable to operate fully within the banking system. The combined effect is a compression of overall market activity alongside a growing reliance on credit-intermediated transactions.

This deterioration in affordability is reflected in several basic indicators. In 2020, the equivalent of 1.7 average monthly salaries was required to purchase one square meter of housing, whereas the current figure is around 2.1 salaries. Similarly, the number of years of average salary needed to purchase a 60-square-meter apartment has increased from 8.7 to 10.3 years. Over the same period, the average apartment price has risen from approximately €45,000 to more than €100,000. These figures point to a substantial increase in the monetary burden linked with homeownership and help explain why market participation has become increasingly dependent on access to formal financing. Alongside these affordability pressures, Moldova has implemented reforms to increase disclosure and traceability of financial flows in real estate transactions. A central element of this process has been the gradual shift away from cash-based transactions toward bank-mediated payments. Historically, a significant share of real estate transactions, particularly in the secondary market, was settled in cash. While this allowed transactions to take place outside the full scope of formal financial intermediation, it also limited authorities' ability to verify the origin of funds, monitor transaction values, and enforce compliance.

The move toward bank-mediated payments, therefore, represents an important institutional change. On the one hand, it improves transparency, strengthens oversight, and supports the formalization of the housing market. On the other hand, it raises the participation threshold by requiring buyers to operate within the formal financial sector. This formalization dynamic interacts directly with affordability constraints. As prices rise, the need for credit or large documented financial resources increases, while restrictions on cash transactions reduce the feasibility of alternative financing modes. The result is not only a more transparent market but also a reconfiguration of market access in favor of buyers who can meet formal financial requirements.

A key regulatory inflection point in this process was the enactment of Law No. 34/2024, which sets strict limits on the use of cash in high-value transactions, including real estate purchases. Transactions above specified thresholds must now be executed through bank accounts or other traceable instruments, effectively eliminating cash settlement for most property transactions. While the law intends to increase financial transparency and align Moldova with international regulatory standards, it also has direct effects on market participation.

By requiring bank intermediation, real estate transactions become subject to standard controls such as identity verification and source-of-funds checks. For buyers whose financial capacity depends on informal income, remittances, undocumented savings, or family-based support, these requirements may create a binding constraint. In this sense, the law functions not only as a restriction on cash payments but also as a screening mechanism. It creates a wedge between the ability to afford a property in economic terms and the ability to demonstrate that capacity within the formal financial system.

The combined effect of affordability pressures and transaction formalization is therefore a shift in the composition of housing demand. These forces do not necessarily reduce underlying demand for housing; rather, they constrain the ability of certain households to convert that demand into formal market participation. As cash-dependent and informally financed buyers are progressively excluded or discouraged, market activity becomes increasingly concentrated among households able to access mortgage credit and comply with formal requirements.

This helps explain how total transaction volumes can decline while the share of bank-intermediated transactions increases. A smaller number of households may be completing purchases, but those who remain active are more likely to rely on mortgages or other traceable financing channels. At the same time, some households may adapt by shifting toward alternative financing arrangements, such as family transfers, remittances, or informal borrowing, that can be routed through the banking system without appearing in mortgage statistics. Although these mechanisms are not directly observable in

aggregate data, they may partially mitigate the decline in effective demand and add to the complexity of the interpretation of official credit indicators.

Taken together, these dynamics point to a reallocation of market participation rather than a uniform contraction in housing demand. Transactions are increasingly concentrated among credit-eligible, formally compliant households, while other potential buyers face growing barriers to entry. This provides the conceptual basis for the divergence between declining transaction volumes and rising mortgage intensity, as analyzed in the following section.

Empirical Evidence: Transaction Contraction and Rising Mortgage Intensity

The contraction in Moldova's residential real estate market becomes strongly apparent when examined dynamically. The number of apartments sold declined from 4,647 in Q4 2024 to 999 in Q4 2025, a nearly 80 percent reduction in a single year. This shows a substantial compression in transaction volume, far exceeding what would be expected from standard cyclical fluctuations.

Importantly, this decline did not coincide with a price correction. As discussed in Section 2.2, apartment prices in Chişinău continued to increase over the same period, ruling out the conventional demand-driven adjustment in which falling transaction volumes are accompanied by declining prices. Instead, the coexistence of lower turnover and sustained price appreciation suggests a contraction in the pool of households able to participate in the market. The constraint, therefore, appears to lie not in underlying housing demand itself, but in potential buyers' ability to convert that demand into formal transactions.

This interpretation is consistent with the institutional and affordability mechanisms outlined earlier. Rising prices have priced out lower-income households and weakened the position of cash buyers, while formalization requirements, particularly those associated with Law No. 34/2024, have raised participation thresholds for households relying on informal, undocumented, or non-bank sources of funds. The observed decline in transaction volume should therefore be understood as a reduction in effective market participation rather than a generalized collapse in housing demand. This distinction is central to the analysis, as it provides the empirical basis for the coexistence of declining turnover and rising mortgage intensity.

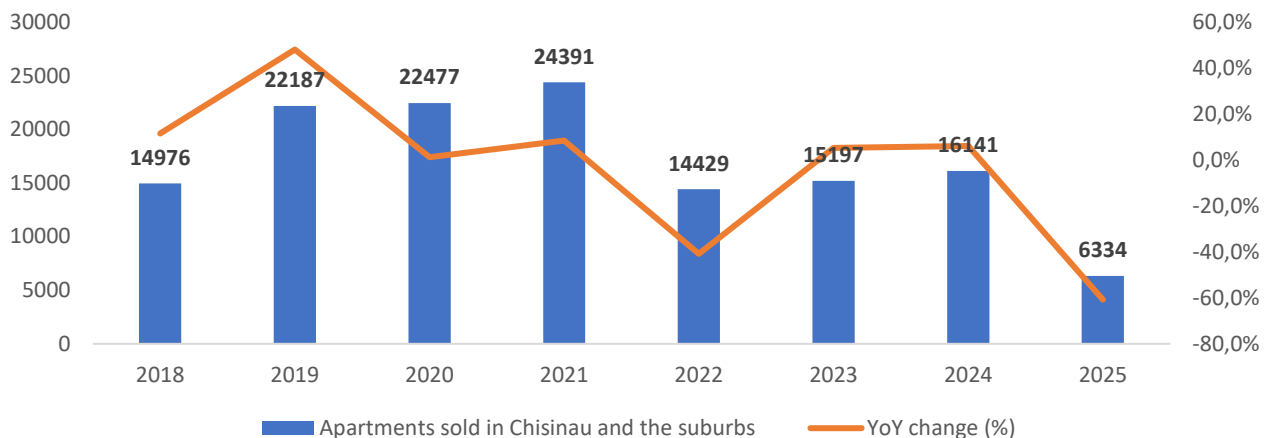


Figure 2. Apartments sold in Chisinau and the suburbs

Source: IPCBI, ASP

The divergence between transaction volumes and mortgage intensity can be accounted for by the interaction of two policy channels. On the one hand, Prima Casă Plus expands the pool of mortgage-eligible buyers by supporting access to formal credit. On the other hand, Law No. 34/2024 constrains participation by cash-dependent buyers by requiring greater fund-tracing and shifting high-value transactions into the banking system. These two mechanisms do not operate in isolation. Together, they reallocate market participation away from cash-reliant or informally financed households and toward buyers who can access bank credit and comply with formal verification requirements.

As a result, total transaction volumes may decline even as mortgage-financed activity is comparatively preserved. The rising share of mortgage-backed purchases is therefore not necessarily evidence of a broad-based expansion in residential demand. Rather, it shows a compositional shift in who remains able to transact and through which financing channels transactions are completed. Within this scheme, the so-called "mortgage paradox" is not a contradiction of standard housing-market dynamics, but a predictable outcome of institutional change. Declining turnover and rising mortgage penetration can coexist when market formalization and affordability pressures narrow the buyer base while increasing the relative importance of bank-intermediated transactions.

This interpretation is reinforced by developments in mortgage lending. In contrast to the contraction in transaction volumes, housing credit has expanded markedly. As shown in Table 2, the stock of outstanding mortgage loans increased from 14.9 billion MDL in 2023 to 26 billion MDL in 2025, signaling a substantial acceleration in credit growth. Over the same period, the share of mortgages in total loans rose from 27 percent to 31 percent, confirming the growing importance of housing credit within the banking sector.

Table 1. Mortgage market indicators

Indicator	2023	2024	2025
Share of mortgages in total loans	27%	29%	31%
Outstanding mortgage loans (bn MDL)	14.9	18.4	26

Source: NBM

These figures point to continued financial deepening despite weakening real estate market activity. In standard housing-market frameworks, mortgage lending typically moves in line with transaction volumes: when market activity weakens, demand for new housing credit would also be expected to slow. The Moldovan case deviates from this pattern. Credit continues to expand even as the number of transactions contracts.

This variation is best perceived through the compositional lens developed above. The expansion of mortgage credit does not necessarily imply that aggregate housing demand is strengthening. Instead, it reflects the rising reliance of a narrower group of active buyers on bank-intermediated financing. As participation becomes increasingly concentrated among credit-eligible households, mortgage lending can continue to grow even while overall market turnover declines. In other words, the market becomes smaller in terms of transaction count but more credit-intensive in its financing structure.

Price changes across market segments further support this interpretation. As shown in Table 3, price growth has been broad-based across both old and new apartments. Between 2023 and Q1 2025, prices for old apartments increased from €880 to €1,324 per square meter, while prices for new apartments rose from €1,295 to €1,906 per square meter. This represents increases of approximately 50 percent and 47 percent, respectively.

Table 2. Price evolution by segment, EUR

Segment	2023	Q1 2025	Change
Old apartments	880	1324	~50%
New apartments	1295	13906	~47%

Source: Acces Imobil

The similarity of price increases across segments suggests that the rise in housing prices is not merely the result of a shift in transactions toward higher-quality or newly built properties. Instead, it reflects generalized upward pressure across the residential market. This distinction is important to understand the decline in transaction volumes. If rising average prices were driven mainly by compositional changes in the types of properties being sold, the implications for affordability would be more limited. However, broad-based price growth reveals a wider deterioration in affordability across the market. These dynamics reinforce the mechanisms discussed in Section 2. As housing becomes less affordable across both old and new apartment segments, participation increasingly depends on access

to formal credit. Cash-dependent buyers and households with irregular or undocumented income are progressively disadvantaged, while credit-eligible households remain better positioned to complete transactions. This simultaneously contributes to lower transaction volumes and to greater reliance on mortgage financing among those who remain active in the market. The result is a more segmented, credit-intensive housing market, in which declining turnover and rising mortgage penetration are not opposing trends but rather interconnected outcomes of the same structural transformation.

Conclusions

This paper examined the divergence between declining real estate transaction volumes and expanding mortgage lending in Moldova. The evidence points to a process of credit deepening under declining market turnover, driven not by a broad-based strengthening of housing demand, but by a structural transformation in market participation and financing.

Three mutually reinforcing forces underpin this shift: deteriorating affordability, which reduces the ability of households to purchase using their own funds; the expansion of subsidized mortgage programs, which sustains access to credit for eligible borrowers; and the formalization of transactions, particularly through Law No. 34/2024, which raises participation thresholds for buyers reliant on informal or non-documented sources of funds. As a result, overall market activity contracts while transactions become increasingly concentrated among credit-eligible households, leading to a higher observed share of mortgage-financed purchases.

These outcomes show that rising mortgage lending should not be interpreted in isolation as an indicator of a strong or expanding housing market. Instead, it may reflect compositional shifts driven by institutional and regulatory changes. Whereas policies promoting credit access and fiscal transparency improve market stability, they can also affect liquidity and access by excluding certain categories of buyers.

At the same time, the analysis is subject to important limitations. First, it is primarily descriptive and does not establish causal relationships between institutional changes and noted market outcomes. While the patterns documented are consistent with the proposed mechanisms, a formal identification strategy would be required to isolate causal effects. Second, the use of aggregate data limits the ability to capture informal or indirect financing mechanisms, such as family transfers, remittances, or private loans. These channels may play an important role in enabling transactions that comply with formal payment requirements without appearing in mortgage statistics. Consequently, the observed increase in mortgage intensity should be understood as a rise in formal, bank-intermediated financing, rather than a complete representation of all funding sources.

More broadly, the Moldovan case shows the need for considering not only the volume of housing transactions, but their composition and financing structure as well. In transition and emerging economies, the interaction among credit policy, affordability constraints, and market formalization can yield outcomes that depart from standard housing market dynamics. Perceiving these interactions is fundamental to correctly interpreting market signals and designing effective policy interventions.

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THE MIDDLE-INCOME TRAP IN THE CONTEXT OF INTRA-EUROPEAN FACTOR MOBILITY: GROWTH PROSPECTS IN THE REPUBLIC OF MOLDOVA

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Abstract: *The Republic of Moldova is officially classified by the World Bank as a lower-middle income economy in 2005, the year in which it signed the EU-Moldova Action Plan, after which it signed the Moldova-European Union Association Agreement in 2014 and in 2021 it becomes officially classified as an upper-middle income economy. European integration is becoming the central development paradigm of the Republic of Moldova, while political association and increased trade are accompanied by increased factor mobility, implicitly by net inflows of private capital from Western European economies into the Moldovan economy, while the labour circulates in the opposite direction, reducing unemployment and fueling consumption through remittances.*

Although this development paradigm facilitates reindustrialization and stimulates economic growth, in the long term it fuels a series of chronic structural imbalances and places the economy of the Republic of Moldova in the "middle income trap", which may obstruct socio-economic convergence in relation to the European Union states and, as a consequence, requires adjustment policies based on comprehensive research.

This article represents a synthesis of this comprehensive research and uses the World Bank methodology for assessing the "middle income trap" and the related strategies for overcoming this trap, relating the existing mechanisms at the international level to the realities of the Republic of Moldova.

Key words: *European integration, factor mobility, economic growth, middle-income trap.*

JEL: E61, F22, F23, J11, L52

Introduction

The World Bank currently classifies 108 countries as "middle-income" – that is, countries with an annual per capita income of between 1,136 and 13,935 US, further divided into upper-middle-income and lower-middle-income economies (Table 1). As they account for half of the world's countries, they are essential for long-term global prosperity, as evidenced by the fact that they account for over 75 percent of the global population, nearly 40 percent of global economic activity, over 60 percent of people living in extreme poverty, and over 60 percent of global carbon dioxide (CO₂) emissions (World Bank, 2024).

The Republic of Moldova was officially classified as a middle-income country on July 1, 2005 (lower-middle income), after which on July 1, 2021 it was classified as an upper-middle income country. European integration and related reforms, even if they had a cyclical dynamic, have contributed to a large extent to economic growth and, implicitly, to the increase in population incomes. The first stages of European integration are associated with institutional modernization and the consolidation of the legal framework in accordance with the commitments of the Moldova-European Union Action Plan or the Moldova-European Union Association Agreement, implicitly complex reforms in the judiciary, the consolidation of a functional market economy, the consolidation of the rule of law and participatory democracy. Also, macro-financial assistance and financing of various sectors of society have contributed to macroeconomic stability and the development of infrastructure projects in localities in the Republic of Moldova.

The European Union is becoming the main trading partner of the Republic of Moldova, while intra-European capital and labour flows are becoming important engines of economic growth and directly responsible for the increase in population incomes and the classification at the upper-middle income country level.

However, long-term growth and economic convergence cannot be sustainable in such an economic model. Growth data prove that the Republic of Moldova is already in the "middle income trap" while intra-European factor mobility represent distinct peculiarities of the context, which require distinct strategies and policies.

European integration and factor mobility: the peculiarities of convergence and middle-income

Both exogenous and endogenous economic growth models articulated within economic growth theories have been derived from the neoclassical production function – $Y = AF(K, L)$ – which considers economic growth (Y_t) as a function of current capital stocks (K_t) and labor (L_t), as well as technological progress/total factor productivity (A_t), but have failed to integrate the international mobility of production factors into a complex model. Economic growth models have most often developed independently and separately from migration theories, which is why most growth models have the variable (L) constant or exogenous and do not consider international labor migration.

Extrapolating neoclassical growth models, however, allows us to conclude that labor migration (L), or the reduction in supply, will reduce global output or Gross Domestic Product (GDP), although it may initially lead to an increase in GDP per capita. Also, the endogenous growth theory starts from the premise that the exodus of human capital (skilled labor) has a positive impact on the growth of host economies and a negative impact on the growth of home economies (World Bank, 2009). The growing body of empirical studies conducted on emerging and/or developing European economies find predominantly negative repercussions of emigration on labor markets, economic growth or public finances. After a series of studies on Eastern European economies investigate the impact of emigration through remittances or brain drain (Ragl, 2017; Leon-Ledesma and Piracha, 2004; Ienciu and Ienciu, 2015), the International Monetary Fund (IMF) models the repercussions of emigration in Eastern Europe, implicitly: the reduction of labor supply (by 10-20%) and the exacerbation of the skilled labor deficit (brain-drain); the reduction of the appetite to work, generated by remittances; the reduction of competitiveness, by increasing the unit cost of labor and, at the same time, by the appreciation of national currencies thanks to remittances; pressure on public finances or; the reduction of the potential for economic growth and convergence with Western European states in the EU (Atoyan et al., 2016). The pressures on growth are quite significant, as evidenced by IMF estimates that migration reduced annual growth rates by 0.6-0.9 percentage points in some countries in the south-east of the European continent in the period 1999-2014, while simulations assume that net migration will continue until 2030 and will reduce GDP and GDP per capita in all countries in the region (Atoyan et al., 2016).

The Republic of Moldova has gradually liberalized the financial and capital account and gradually aligned the national framework on the free movement of persons, including relevant regulations on labor migration. Intra-European mobility of capital and labor has always followed the neoclassical model in the Republic of Moldova, implicitly Western European capital in the form of direct investments (FDI) entered the national economy and, along with other types of financial flows, greatly stimulated public and private investments in gross fixed capital formation and quantitative economic growth. Thus, data on domestic savings and gross fixed capital formation in the Republic of Moldova show that there is a large gap between gross domestic savings and long-term investments, proof that these investments are financed predominantly by savings from the European Union, implicitly through the net increase in external liabilities (Figure 1).

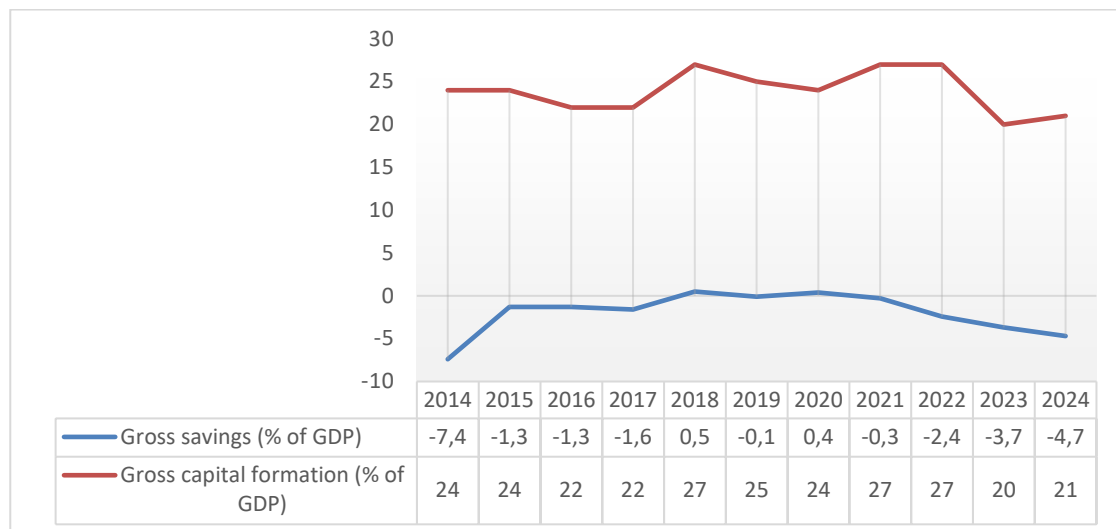


Figure 1. Gross savings and gross capital formation in the Republic of Moldova.

Source: data.worldbank.org

The dynamics of liabilities in the form of direct investment also confirm neoclassical assumptions about international capital flows. Thus, from non-existent or insignificant volumes in the years of independence and gradual growth during the difficult transition in the 1990s, there follows the growth of FDI associated with the growth of the global economy until the Great Recession of 2008-2009, when inflows of liabilities in the form of direct investment reach the value of 711 million USD (UNCTAD, 2025). Two more cycles of fall and recovery follow, implicitly in the years 2016 and 2020, after which a new investment peak in 2023 with FDI of almost 600 million USD and the moderation in 2024, when direct investment amounted to about 344 million USD (Figure 2). Data from the National Bank of Moldova show that liabilities in the form of direct investments amounted to EUR 5,373.3 million at the end of 2025, of which equity amounted to EUR 3,720.8 million and debt instruments amounted to EUR 1,652.5 million. In the geographical distribution of direct investments in the form of accumulated participations and shares (equity), including reinvested income/losses, those in EU countries totaled EUR 3,143.6 million, or approximately 85% (NBM, 2026). Empirical studies conducted in the Republic of Moldova, based on econometric models, show a positive relationship between FDI and economic performance (Macovei and Pârțachi, 2025).

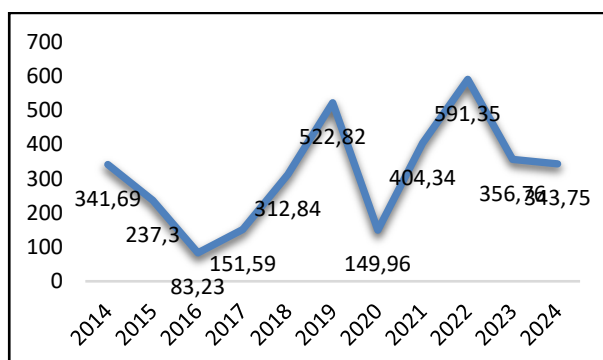


Figure 2. FDI in the Republic of Moldova (thousand USD).

Source: adapted from UNCTAD World Investment Report 2025 data.

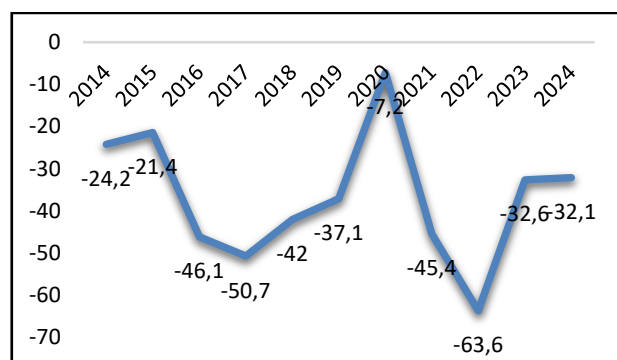


Figure 3. Net international migration (thousands of people)

Source: adapted by the author according to NBS data.

Labor flows have been predominantly in the opposite direction to capital flows, in the context of wage differences existing on the European continent, implicitly in the EU internal market. Contrary to neoclassical assumptions that argue that, internationally, labor is less mobile than capital, labor is more mobile in Eastern Europe and in the Republic of Moldova, evidence that European capital employs more Eastern European workers in Western Europe, in the countries of origin of capital, than in Eastern Europe,

the countries of origin of workers. Thus, net international migration, which although experiencing a cyclical evolution, is consistently negative in the Republic of Moldova (Figure 3).

Net migration has become part of the development paradigm of the Republic of Moldova, largely absorbing negative shocks to external demand by reducing the unemployment rate, which has fluctuated between 3-5% in the last decade, and, most importantly, through remittances received by residents of the Republic of Moldova, which were comparable to exports and largely supported private consumption, respectively economic growth. Although decreasing, from a peak of 34.5% of GDP in 2006 to 10.5% of GDP in 2024, external remittances remain crucial for covering the current account deficit, as well as for the consumption-driven growth model, since on the use side, about 86% of GDP is formed by household consumption. Not only economic growth but also the convergence and increase in average incomes of the population is determined predominantly by negative net migration from the Republic of Moldova, implicitly qualifying for the status of upper-middle income country (Figure 4).

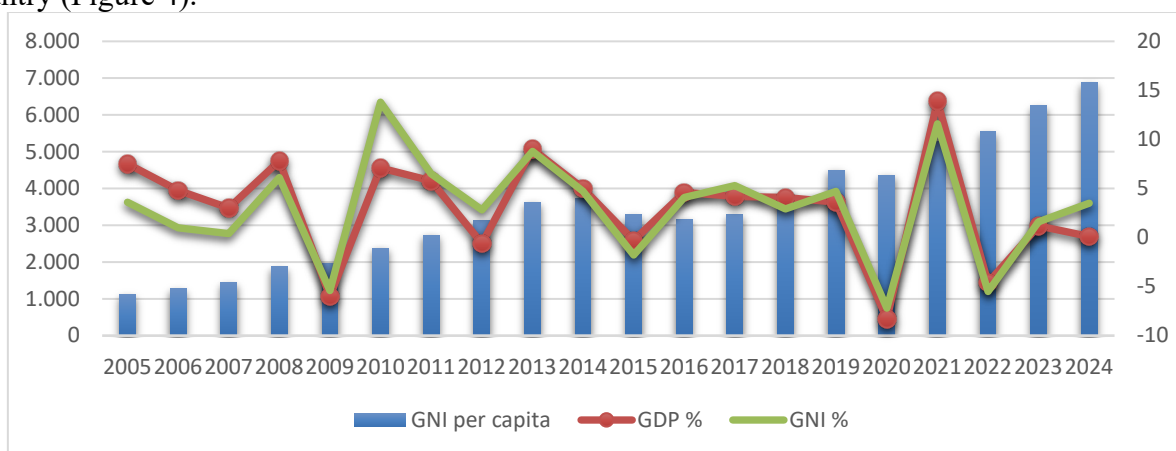


Figure 4. GDP, GNI and GNI per capita growth in Republic of Moldova

Source: data.worldbank.org

Economic growth has been cyclical in the Republic of Moldova for the two decades since it entered the category of middle-income countries. At the same time, the data in Figure 4 show that, during the period 2005-2024, GDP increased in real terms and GNI per capita in the Republic of Moldova increased by more than six times. Therefore, the dynamics of GNI per capita reflects the cumulative effect of several factors, implicitly real economic growth, changes in net income from abroad (especially remittances), as well as demographic contraction mainly determined by negative net migration, processes particularly supported by the European integration of the Republic of Moldova, implicitly by intra-European factor mobility.

Overcoming the middle-income trap: strategies and reforms

The notion "middle-income trap" was first defined by the World Bank in 2007, in the context of income classifications of the world's countries and recommendations to avoid this status for East Asian countries (Gill, 1997). Starting from the income classification of countries, whose thresholds for 2026 are presented in Table 1, subsequent research has further developed the criteria by which an economy is in the "middle-income trap" state and the strategies to overcome this condition.

Table 1. World Bank income classifications (U.S. dollars)

	<i>Low Income</i>	<i>Lower-Middle income</i>	<i>Upper-Middle Income</i>	<i>High Income</i>
<i>July 1, 2025 (new, for FY26)</i>	≤ 1,135	1,136 - 4,495	4,496 – 13,935	> 13,935
<i>July 1, 2024 (previous, for FY25)</i>	≤ 1,145	1,146 - 4,515	4,516 – 14,005	> 14,005

Source: World Bank Group income classifications for FY26

According to the World Bank methodology, an economy can be considered to be in the "middle-income trap" when, after entering the middle-income club (currently GNI per capita between USD 1,136 and USD 13,935), it experiences a persistent slowdown in economic growth and fails to converge towards advanced economies within a reasonable time horizon. The phenomenon is associated with the maintenance of a growth model based predominantly on capital accumulation, without an adequate transition to technological diffusion and innovation, as well as with institutional constraints and high vulnerability to external shocks (World Bank, 2024).

The data on the Republic of Moldova are close to the World Bank diagnosis. Thus, the economy of the Republic of Moldova recorded an average annual growth rate of approximately 3.5% for real GDP and about 3.7% for GNI, but beyond the average of the two decades of a middle-income economy, the analysis of data for each decade demonstrates a slowdown in growth:

- 2005-2014 – 4.3% average GDP growth rate and 4.2% average GNI growth rate. The most dynamic period of economic activity in the history of the Republic of Moldova, supported on the demand side by the increase in household consumption fueled by the increase in remittances.
- 2015-2024 – 1.9% average GDP and GNI growth rate. The moderation of the growth rate, caused not only by repeated external shocks (COVID-19 pandemic, energy crisis, regional geopolitical instability), but also by the exhaustion of the growth model.

Therefore, the analysis by sub-periods highlights a significant slowdown in the economic growth rate in the Republic of Moldova, from approximately 4.2%-4.3% annually in the period 2005-2014 to approximately 1.9% after 2015. This deceleration cannot be explained only in terms of overlapping crises, but suggests the existence of internal imbalances and the partial exhaustion of initial convergence factors and indicates the existence of structural constraints on medium and long-term economic growth - the "middle-income trap".

After the authors of the term "middle-income trap" propose Schumpeterian growth models, which emphasize creative destruction and institutional change, as the basis for strategies to overcome the trap, the World Development Report 2024 presents a strategy structured in three stages, which must also be considered for the case of the Republic of Moldova (Figure 5).

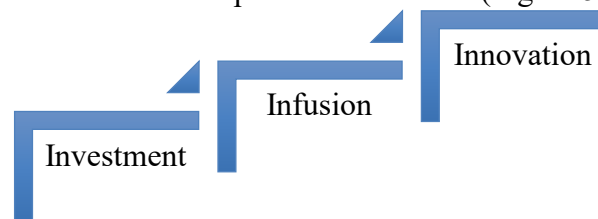


Figure 5. Strategy „3i”

Source: World Bank. 2024. World Development Report 2024: The Middle-Income Trap. Washington, DC: World Bank

Thus, according to the WB, overcoming the middle-income trap requires a sequential strategy based on three interdependent pillars: efficient investments; diffusion of existing technology and development of innovation capacities. The WB report emphasizes that these three dimensions are not substitutable, but complementary, but the transition between these stages reflects the move from an extensive growth model, based on the quantitative increase of factors (especially capital), to an intensive model of efficiency growth, oriented towards productivity and endogenous technological progress (World Bank, 2024).

The reforms in recent years and the policy documents approved by the Government of the Republic of Moldova have mainly targeted the first two i, in the context of attempts to change the development paradigm from a consumption-driven model to an investment-driven model, respectively investments and the infusion of technology by attracting foreign direct investment, recommended by the World

Bank for lower-middle income countries (World Bank, 2024). In this context, the Ministry of Economic Development and Digitalization has developed and is implementing the first mechanism to stimulate investments in the manufacturing industry aligned with European Union rules on state aid, the Regional State Aid Scheme for Investments, approved by Government Decision no. 875/2024. State aid is granted through two complementary instruments: a grant, in the proportion of 25% of the total value of the approved aid, and a partial exemption from income tax, in the proportion of 75%. On May 1, 2026, 28 companies were beneficiaries of the pre-booked state aid scheme, with an expected investment volume of approximately 2.76 billion lei and the total number of jobs expected to be created is 1,572 (MEDD, 2026).

At the same time, the realities of the Moldovan economy, along with the World Bank's set of recommendations for overcoming the middle-income trap, require the development and implementation of the second stage of transformations, transformations recommended for successful upper-middle income countries, namely the transition to an innovation strategy. With R&D investments of 0.22% of GDP, the Republic of Moldova invests ten times less in research and development than the European Union member states, which in turn are less competitive internationally, according to The Draghi report on EU competitiveness (Draghi, 2024). In this context, attracting private capital in research and development becomes imperative, while the interest of domestic companies in the above-mentioned state aid scheme for investments recommends the development and implementation of a state aid scheme for research, development and innovation. The development and implementation of this mechanism initially requires the updating of the Regulation on aid for research, development and innovation, approved by the Competition Council Decision no. 8/2013, after which the Ministry of Economic Development and Digitalization developed and the Government approved a state aid scheme for research, development and innovation.

Also, in order to streamline the support mechanism and capitalize on the potential of the private sector, the state aid scheme for research, development and innovation must be implemented in parallel with the development of Innovation Intermediaries. Marked by a dynamic development in recent decades, implicitly different names and functions (Caloffi, 2023), Innovation Intermediaries are essential for the digital transition of contemporary economies and, consequently, become crucial for stimulating innovation and its commercialization in the Republic of Moldova. Innovation intermediaries are involved on both the demand and supply sides of innovation and technological solutions, as they mediate between organizations that request innovation and technology (large companies, SMEs or public authorities) and organizations that provide technology or innovation (large companies, SMEs, universities and public research organizations) (Rossi et al., 2020).

Beyond understanding the needs and developing the strategies recommended by the World Bank, the growth in the context of intra-European mobility of capital and labor has accentuated a series of internal imbalances that require structural reforms and additional institutional modernizations to successfully overcome the middle-income trap. Constantly negative net migration has generated a skilled labor shortage that puts pressure on the country's sustainable growth and does not allow the activation of the internal depreciation mechanism, as a mechanism to cushion external shocks. Also, vertical foreign investments, attracted by cheap labor, cannot continue to constitute a feasible mechanism for technology infusion and the engine of economic growth, while increased electricity costs put pressure on existing economic sectors and obstruct the development of new, energy-intensive economic sectors.

Therefore, forced by the context to accelerate or even skip growth stages – from a consumption-driven model to an investment model –, faced with a series of structural imbalances and affected by regional geopolitical instability and overlapping crises, the Republic of Moldova must rethink its development model and capitalize on the opportunities existing in the European integration process.

Conclusions

Capital and labor flows are complementary in an integrated market where there are differences in profit margins and wages, while labor is more mobile than capital, contrary to neoclassical assumptions. In the context of reduced domestic savings, the financing of investments and gross fixed capital formation in the Republic of Moldova is predominantly ensured by capital inflows, implicitly in the form of direct investments. Capital inflows, particularly liabilities in the form of direct investments, are not yet sufficient to stimulate sustained growth in the Republic of Moldova and/or to employ the entire economically active population with competitive wages, while a large part of the labor force emigrates to the Western European labor market, generating imbalances in the labor market and limiting the adjustment mechanism to external shocks. At the same time, after European integration stimulated economic growth and development in the Republic of Moldova, implicitly through intra-European factor mobility, stimulating entry into the club of upper-middle income states, there is a significant slowdown in the pace of economic growth, from approximately 4.2%-4.3% annually in the period 2005-2014 to approximately 1.9% after 2015. This deceleration cannot be explained only in terms of overlapping crises, but suggests the existence of internal imbalances and the partial exhaustion of initial convergence factors and indicates the existence of structural constraints on medium and long-term economic growth – the “middle-income trap”. Sustainable economic growth requires targeted policies to stimulate investment, mitigate imbalances on the labor market and policies to stimulate efficiency and productivity – structural reforms and innovation.

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ASSESSMENT OF THE DEGREE OF READINESS OF THE REPUBLIC OF MOLDOVA FOR EU ACCESSION THROUGH THE LENS OF THE MAASTRICHT CRITERIA

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Abstract: *This study analyzes the prospects of EU accession of Republic of Moldova through the lens nominal convergence, also known as Maastricht criteria. Four indicators were analyzed and compared to EU benchmark: price stability, the sustainability of public finance, long-term interest rates and exchange rate stability. The results indicate the economic performance of Republic of Moldova at current state regarding the requirements in adopting the euro and highlight challenges faced by regional countries that are distinctive for emerging economies, such as catching-up effect and structural economic differences between EU member countries and countries on their way to accession. Generally, none of the Maastricht criteria are currently fully met, considering higher than required inflation rate and long-term interest rates, lack of alignment with the Exchange Rate Mechanism II (ERM II), and a high budget deficit. While analysis of experience of regional countries highlights diverse outcomes and time horizons for euro adoption, meeting nominal convergence criteria for Republic of Moldova is supposed to be possible only after achieving EU membership, following years of external assistance and structural economic transitions toward EU standards.*

Keywords: *nominal convergence, Maastricht criteria, price stability, exchange rate stability, fiscal sustainability*

JEL: F15, E62, P27

Introduction

In recent years, the Republic of Moldova has made significant strides in its accession toward the European Union. As the regional situation is strained by geopolitical and economic —such as the war in Ukraine, trade embargoes, and energy crises— EU integration holds strategic importance for long-term economic development and sovereignty. Thus, in recent years have been made big advances, for instance European Council granted Moldova the status of EU candidate country on 23 June 2022, while on 14 December 2023, the Council decided to open accession negotiations. Nevertheless, there is still a long way and numerous changes required in order to align to European standards.

The work focus is on assessing nominal convergence by examining the state of accession through the Maastricht criteria and analyzing the strengths and weaknesses of the current economic environment. Thus, the purpose of the article is by measuring the gap between actual Moldova's indicators and required thresholds to evaluate current state and future perspectives of Euro adoption.

It is important to note that while the Maastricht criteria are prerequisites for adopting the Euro, they are not strictly mandatory for initial EU membership. Accordingly, four indicators were analyzed: price stability, budget deficit and state debt (for measuring fiscal sustainability), exchange rate stability, and long-term nominal interest rates. As literature review and experience of other countries from region will show later, usually Maastricht criteria are met after accession, through years of institutional and economic adjustments to EU standards.

The structure of the study as follows: the first part literature review regarding importance of nominal convergence and analysis of regional states experience, then the methodology of measuring and comparing Maastricht criteria is analyzed as it is stated by European Commission. Finally, the measurement and comparison of Moldovan indicators regarding the reference values (benchmarks

for meeting the criteria) are performed, followed by conclusions, future outlook and policy recommendations.

Literature review

The economic rationale underpinning the drive for EU accession is rooted in the theory of convergence. The mechanism of convergence can be met in many works regarding economic growth, most notably, the Solow growth (Solow, 1956) model predicts capital-scarce economies to experience higher growth rates than capital-abundant ones. This leads to absolute convergence in scenarios where structural parameters are identical, which of course is not the case if we speak about economy of RM in comparison with EU. However, in practice, this catch-up is often 'conditional', occurring only when countries align their savings rates, demographic trends, and technological levels. Furthermore, the beta-convergence hypothesis developed by Barro and Sala-i- Martin (Barro and Sala-i-Martin, 1992) suggests that lower-income economies exhibit higher growth rates than more advanced. This inverse relationship between initial income and growth is also known as a 'catch-up' effect in per capita income levels over the long term and will be discussed later as one of the challenges emerging economies like the Republic of Moldova, Romania, Bulgaria face in form of inflation pressure and higher long-term interest rates.

As this research focuses on nominal convergence, it is important acknowledging that the Maastricht criteria function primarily as a framework for price and fiscal stability. This perspective aligns with Afxentiou's (2000, p. 248) assertion that the Maastricht requirements have a limited relationship with 'convergence proper.' Whereas the latter represents a structural process of catching up through technological integration and institutional reform, the former represents a set of nominal benchmarks.¹ In this context, the four criteria were established by the EU Member States in Maastricht in 1991. Compliance with these criteria was intended to ensure a harmonized fiscal and monetary landscape, providing a base for participation in a highly integrated European economy (Afxentiou, 2000, p. 252). As stipulated by the European Commission, these benchmarks comprise: price stability, the sustainability of public finances, exchange rate stability, and the durability of convergence (that is measured through long-term interest rate levels).

As the Republic of Moldova is an emerging economy, it possesses distinct structural characteristics that differentiate it from established EU member states. These differences pose some challenges to fulfilling the Maastricht criteria. Thus, emerging economies are expected to grow at a significantly faster rate than developed ones, however, this catch-up effect is a double-edged sword (Abramovitz, 1986), meaning that according to the Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964), rapid productivity growth in the manufacturing sector also exerts upward pressure on wages in services industry that leads to proportionate increase in wages across the entire economy, i.e. leading to inflation pressure and higher long-term interest rates. As a result, the Republic of Moldova faces persistent structural pressure that complicates the maintenance of price stability and exchange rate consistency at the same time as required by the Maastricht framework.

The literature reveals that while some countries have successfully navigated these structural challenges, others continue to face difficulties. For instance, the Convergence Report (European Commission, 2022) noted that Croatia's underlying economic factors were sufficiently robust to support a sustainable convergence path in the medium term. This positive assessment paved the way for Croatia to adopt the euro in 2023. Notably, Croatia remained an EU member for a decade before fulfilling the nominal convergence criteria. This transition was characterized by close collaboration with European authorities, particularly the ECB (2020), which began directly supervising Croatian credit institutions. Consequently, these institutions became subject to the same supervisory standards and procedures as their counterparts within the Eurozone.

Similarly, the 2025 Convergence Report (European Commission, 2025) on Bulgaria indicated that the Bulgarian financial sector exhibited resilience since 2009 financial crisis and was stable during pandemic and energy crises. Again, as the adoption of euro for Bulgaria was possible with close interconnection of the banking sector and ECB, accession of Bulgaria to the Banking Union in 2020 and direct supervision by the ECB of commercial banks that hold approximatively three quarters of all assets in the banking sector. Thus, in 2026 Bulgaria became the last up to date country that adopted Euro.

In contrast, despite its earlier accession to the EU, Romania has yet to implement the euro—unlike Croatia. As noted by Iancu (2017), Romania briefly fulfilled all five nominal convergence criteria in 2015. However, while Romania exited the Excessive Deficit Procedure in 2013 and the Macroeconomic Imbalance Procedure in 2016, challenges remain. According to Iancu (2017), authors of the Maastricht Treaty established criteria for Member States with a derogation without providing sufficient mechanisms to resolve structural asymmetries, particularly in less-performing economies. Transitioning from a national currency to the euro involves complex mechanisms that can be difficult for asymmetric economies to manage. Furthermore, aggressive attempts to meet these criteria—especially the strict ERM II exchange rate bands—can occasionally trigger economic divergence or exposure to external shocks. It is also important to remember that joining the Eurozone is not a unilateral decision, it is a multi-stage process requiring rigorous analysis, reports, and a final favorable vote from existing Eurozone members.

Regarding the Republic of Moldova, there is currently no official target date for the transition to the euro.

Methodology

As a methodology and benchmarks for measuring economic convergence of the Republic of Moldova was taken according to four legally binding economic conditions that EU Member States must meet to adopt the euro, as outlined in the Treaty on the Functioning of the European Union.

Price stability

Article 1 of Protocol (No. 13) on the convergence criteria stipulates that the criterion on price stability requires a Member State to demonstrate a sustainable price performance. Specifically, the average rate of inflation, observed over a period of one year prior to examination, must not exceed the inflation rates of the three best-performing Member States by more than **1.5 percentage points** (European Union, 2008).

In this study, the inflation rate was calculated based on the change in the 12-month average of the price index for the reference period of January to December 2025, compared to the preceding 12-month average. While the ECB utilizes the Harmonized Index of Consumer Prices to ensure cross-country comparability, such a metric is currently unavailable for the Republic of Moldova. Consequently, it was used for comparison the national Consumer Price Index as a representative proxy. Furthermore, the reference value is determined by taking the unweighted arithmetic average of the inflation rates of the three best-performing Member States (excluding outliers). Also, it is important to exclude outliers, as the methodology stipulates that a Member State is identified as an outlier if its inflation rate is significantly below the Eurozone average and its price developments are driven by exceptional, non-structural factors (European Commission, 2025).

Sound and sustainable public finances

The second pillar of nominal convergence, as stipulated in Article 140(1) of the Treaty, concerns the sustainability of the government's financial position. A Member State is deemed compliant if it maintains a budgetary position free of an "excessive deficit," a status determined through the Excessive Deficit Procedure under Article 126 (European Union, 2012).

The evaluation of fiscal discipline focuses on two benchmarks:

1. Budget deficit criteria: the ratio of the annual general government deficit to GDP must not exceed 3%. Exceptions are granted only if the ratio is significantly and steadily declining toward the threshold or if the breach is considered to be temporary and exceptional.
2. Debt criteria: gross government debt-to-GDP ratio must remain below 60%. If a country exceeds this limit it must demonstrate that the debt ratio is decreasing and converging toward the 60% benchmark.

Exchange rate

The third pillar of nominal convergence, as defined in Article 140(1) of the TFEU and further detailed in Protocol (No. 13), assesses a Member State's ability to maintain a stable currency without distorting the internal market. It means that practice the ECB evaluates the country participation in ERM II and compliance requires a two-year period of participation during which the national currency remains within $\pm 15\%$ bands against the euro (European Union, 2008).

For countries under a "derogation" that have not yet entered ERM II, such as the Republic of Moldova, the assessment methodology shifts. Thus, the work focuses on the degree of exchange rate volatility and the overall performance of the national currency against the euro. This provides a proxy assessment of the exchange rate stability of Moldovan Leu.

Long term rates

The fourth and final pillar of nominal convergence, as specified in Article 140(1) of the Treaty and further detailed in Protocol (No. 13), assesses the durability of convergence through the lens of long-term interest rates. The treaty stipulates that over a period of one year before the examination, a Member State has had an average nominal long-term interest rate that does not exceed by more than 2 percentage points that of the three best performing Member States in terms of price stability (European Union, 2008).

Thus, for the purposes of this study, the average nominal long-term interest rate is calculated as the arithmetic average over a 12-month reference period. In alignment with the price stability evaluation, the reference period considered in this analysis spans from January to December 2025.

Methodologically, interest rates are measured based on yields of long-term government bonds (typically with a 10-year maturity) or comparable securities on the secondary market. These yields are ideally "harmonized" to ensure cross-border comparability. But, for the Republic of Moldova, where the secondary market for 10-year government bonds may lack the liquidity found in Eurozone counterparts, this analysis utilizes the most comparable available long-term sovereign yields as a proxy for the convergence assessment (7 and 10 year bonds).

The required criteria can be summarized in the following table:

Table 1. The four convergence criteria

What is measured:	Price stability	Sound and sustainable public finances	Durability of convergence	Exchange rate stability
How it is measured:	Harmonised consumer price inflation	Government deficit and debt	Long-term interest rate	Exchange rate developments in ERM II
Convergence criteria:	A price performance that is sustainable and average inflation not more than 1.5 percentage points above the rate of the	Not under excessive deficit procedure at the time of examination	Not more than 2 percentage points above the rate of the three best performing Member States in	Participation in ERM II for at least 2 years without severe tensions, in particular without

	three best performing Member States		terms of price stability	devaluing against the euro

Source: European Commission

Results and discussion

As for situation of January – December 2025, on the basis of last 12 months HICP, the three best performing European States in terms of price stability were Cyprus (0.8%), France (0.9%) and Italy (1.6%). Adding 1.5 percentage points to the average of these three rates, the reference value for the price stability criterion of 2.6% was obtained. Although Switzerland had an inflation of 0.1% it was excluded from calculation as considered an outlier, considering average EU-27 inflation based on HICP for 2025 was 2.5%. As for the Republic of Moldova, for the same period of time, as a metric was chosen average 12 months average CPI of 7.8% (due to non-existence of a harmonised index). The 2025 value is slightly above 2024. The increase in inflation was determined by the increase in gas, thermal energy and electricity tariffs. Thus, inflation gap between the Republic of Moldova and the benchmark with buffer is 4.2%, higher above the required limit. This rate is expected to decline gradually in 2026-2027, but is expected to situate among 5%, as it is the target inflation rate of the NBM. The catching-up process is also likely to result in positive inflation differentials vis-à-vis the euro area over the longer term, since GDP per capita and price levels are still significantly lower in Republic of Moldova than in the euro area.

From a legal standpoint, the Republic of Moldova is not currently subject to a Council Decision regarding the existence of an excessive deficit, as the Excessive Deficit Procedure applies strictly to EU Member States. However, the general government deficit currently exceeds the 3% reference value. Projections from the Ministry of Finance, indicate that the deficit is expected to persist at approximately 5% of GDP over the next three years. Nevertheless, the general government debt in GDP is maintain below the level of 60%. Even though its expected to increase up to 46% in the next 3 years (State Debt Management Program, 2026–2028), this level is still below the reference value and contrasts the high budget deficit.

While the Republic of Moldova does not currently participate in the ERM II, making the formal two-year stability requirement technically inapplicable. Although, the progress for matching currency exchange rate and removing deviation from euro is notable. Thus, at the beginning of 2025 the NBM officially designated the euro as the monetary anchor for the Leu's exchange rate, superseding the US dollar (NBM, 2025) and reflecting the Republic of Moldova's economic shift towards the European Union market, which plays a significant role in the country's trade and financial structure. As evaluation of last 3 years exchange rate reveals, appreciation/depreciation of the Moldovan Leu against the Euro was between +2%, which can be considered as stable.

Long-term interest rate is another dilemma of estimation in order to align with Maastricht criteria. The primary obstacle is that Moldova's capital market remains in an embryonic stage, thus, fixed income market lacks a diverse range of instruments necessary to derive a long-term rate. Most of the bonds are issued by the government and up to 5 years. Nevertheless, by utilizing a limited sample of existing government bond issuances with maturities of 7 and 10 years, a long-term interest rate indicator was constructed for comparison against the reference value. Thus, at the end of 2025 the annual long-term interest rate constituted 8.2%.

The reference value was derived from the 12-month average of harmonized long-term interest rates (based on 10-year benchmark bonds) for Italy, France, and Cyprus. By adding the mandated two-percentage-point margin to the 3.3% average yield of these three nations, a reference threshold of 5.3% was established.

Table 2. Maastricht criteria and RM performance

	Price stability	Government budgetary developments and projections			Exchange rate		Long-term interest rate ⁵ , %
	HICP inflation ¹ , %	Country in excessive deficit ²	General government surplus (+) / deficit (-) ³ , %	General government debt ³ , %	Currency participating in ERM II	Exchange rate vis-à-vis the euro ⁴ , %	
2023	13.4	No	-5.1	34.3	No	+1.3	8.1
2024	4.7	No	-3.9	37.5	No	+2.0	6.7
2025	7.8	No	-4.1	37.6	No	-1.8	8.2
Reference value ⁶	2.6		-3.0	60.0			5.3

Sources: European Commission (Eurostat, Directorate-General for Economic and Financial Affairs) and Statistica.md
Notes:

- 1) Average annual percentage change. Data for 2025 refer to the period from January 2025 to December 2025.
- 2) Refers to whether a country was subject to an EU Council decision on the existence of an excessive deficit for at least part of the year. Not applicable to RM as it is not an EU member yet.
- 3) As a percentage of GDP. Data for 2025-27 are taken from the State Debt Management Program, Ministry of Finance.
- 4) Annual percentage change. A positive (negative) number denotes appreciation (depreciation) vis-à-vis the euro.
- 5) Average annual interest rate. Reference value was calculated as a simple average of harmonised long-term interests of Cyprus, Italy and France. Value for RM was calculated as an average of 7 and 10 years government bonds issues.
- 6) The reference values for HICP inflation and long-term interest rates refer to the period from January 2025 to December 2025; for the general government balance and debt, the reference values are defined in Article 126(2) of the Treaty on the Functioning of the European Union and the related Protocol (No 12) on the excessive deficit procedure.

As a summary of table 2, for the end of 2025 we have higher than required inflation rate, that could be explained by both pressure from high energy prices and catching-up effect of the Republic of Moldova as an emerging country. Still, considering the current target inflation rate of NBM of 5%, it is a divergence between objectives of NBM for price stability and criteria dictated by Maastricht. At the same time, RM faces big budget deficit last years and is expected to continue this trend. Nevertheless, low government debt in GDP contrasts in a positive way, but still is also expected to continue increasing in future. Also, despite low currency deviation of exchange rate for Moldavian leu against Euro, participation in ERM II is expected to be implemented and last for a term of at least 2 years in order to meet the requirements. It is supposed to postpone euro implementation for another years. Finally, as expected by higher ICP, the long-term rates are also higher than reference value.

Conclusions

The study analyzed the economic performance of the Republic of Moldova in the context of the requirements set by the Maastricht Treaty. As the experience of regional countries that have adopted the euro demonstrates, the monetary integration of the Republic of Moldova is expected to occur only after its accession to the EU. This process will require several years of institutional and economic convergence to mitigate the structural differences between the economies of EU member states and that of the Republic of Moldova.

Specifically, the Republic of Moldova's macroeconomic alignment with the Maastricht criteria as of 2025 presents a mixed picture. While the country demonstrates positive performance by maintaining a compliant general government debt-to-GDP ratio and a stable exchange rate against the Euro, significant gaps persist. First, Moldova's inflation rate remains above the European reference value. This challenge is further compounded by the inherent divergence between the NBM's 5% inflation target and the stricter Maastricht threshold. Second, continuous budget deficits exceeding the 3% limit and elevated long-term interest rates underscore ongoing fiscal and financial challenges. Third, despite a relatively stable currency exchange rate, closing these macroeconomic disparities requires

formal participation in ERM II for at least two years. Thus, all these factors dictate that the Republic of Moldova's full integration into the Eurozone will inevitably be postponed for the foreseeable future.

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DIGITAL READINESS OF MOLDOVAN SMES FOR CROSS-BORDER E-COMMERCE: A PATHWAY TO EU MARKET INTEGRATION

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Abstract: *The development of cross-border e-commerce represents a strategic opportunity for small and medium-sized enterprises (SMEs) in the Republic of Moldova to access the European Union market with lower entry costs and greater operational flexibility than traditional internationalization channels. However, the effective use of e-commerce as an export mechanism depends not only on internet access or the existence of online shops, but on the broader digital readiness of firms — understood as the capacity to integrate and operationalize digital tools within export-oriented business processes. This article examines the digital readiness of Moldovan SMEs for cross-border e-commerce and evaluates its relevance for EU market integration. The analysis draws on institutional reports, policy documents, and academic literature on e-commerce development, digital transformation, SME capabilities, and EU digital market requirements. The findings suggest that Moldova has made visible progress in expanding e-commerce infrastructure, digital policy frameworks, and online retail activity. Nevertheless, major constraints persist: limited use of online payments, weak inventory management systems, insufficient digital business skills, fragmented logistics, and incomplete regulatory adaptation. The article argues that these constraints are particularly acute for cross-border export contexts, where EU consumer protection standards and platform requirements exceed domestic thresholds. Cross-border e-commerce can become a realistic pathway to EU market integration only if Moldovan SMEs develop firm-level capabilities in digital marketing, online payments, data management, logistics, compliance, and customer protection. Public policy should therefore move beyond general digitalization objectives and focus on practical, export-oriented e-commerce readiness for SMEs.*

Keywords: *digital readiness, SMEs, Moldova, cross-border e-commerce, EU market integration, digital transformation, international competitiveness.*

JEL: F23, L81; O33; M16; F15; L81

Introduction

The integration of the Republic of Moldova into the European economic space increasingly depends on the country's ability to modernize its productive structure, strengthen SME competitiveness, and connect domestic firms to external markets. In this context, cross-border e-commerce has emerged as more than a technological channel for selling goods and services. It represents a potential mechanism for reducing market-entry barriers, increasing export diversification, and supporting the gradual alignment of Moldovan businesses with European market standards. Yet the pathway from domestic digitalization to EU export performance is neither automatic nor linear, and the existing literature offers limited guidance on transition economies at an early stage of both e-commerce development and EU integration.

For SMEs, traditional export expansion typically requires significant financial, logistical, and institutional resources: identifying foreign distributors, negotiating contracts, adapting to complex regulatory frameworks, and managing cross-border delivery. Cross-border e-commerce alters part of this logic by allowing firms to reach foreign consumers directly through digital platforms, marketplaces, social media channels, and online payment systems. The academic literature increasingly treats cross-border e-commerce as a foreign market entry mode, not merely a supplement to offline export activity. Cassia and Magno (2022, pp. 267–268) demonstrate, drawing on a sample

of Italian food and beverage exporters, that the performance of SMEs in cross-border e-commerce depends on firm-level capabilities in information technology, international marketing, and export operations management, with third-party platform use partially substituting for internal IT infrastructure. Critically, the three capability dimensions exert differentiated effects on strategic versus financial performance — a distinction relevant for Moldovan SMEs that may seek to build brand presence in EU markets before achieving financial returns (Cassia and Magno, 2022, p. 278). For Moldova, the relevance of this issue is reinforced by the country's strategic orientation toward European integration. Moldova received EU candidate status in 2022 and formally opened accession negotiations in 2024. The Digital Transformation Strategy 2023–2030 explicitly links digital development with the European integration agenda, emphasizing electronic services, ICT sector development, institutional efficiency, cybersecurity, and the creation of a digital national brand (Ministry of Economic Development and Digitalization of the Republic of Moldova, 2023). These objectives create a favorable policy context, but they do not automatically ensure that SMEs are prepared to use e-commerce for EU market access. The gap between national-level policy ambitions and firm-level operational readiness constitutes the central analytical problem of this article.

The objective of this article is to assess the level of digital readiness of Moldovan SMEs for cross-border e-commerce and to identify the main structural, organizational, and regulatory barriers affecting their integration into EU digital markets. The article contributes to the literature by linking SME digital readiness with EU market integration in the specific context of a candidate country with an emerging e-commerce ecosystem. The central research question is: to what extent are Moldovan SMEs digitally prepared to use cross-border e-commerce as an instrument for entering and expanding within the EU market?

Methodology

A consistent challenge in researching Moldova's e-commerce sector is that firm-level data — disaggregated by enterprise size, sector, and cross-border trading status — is largely unavailable. The monitoring infrastructure for digital trade in Moldova does not yet generate the granular statistics that a conventional quantitative analysis would require. This study therefore proceeds through a qualitative assessment of secondary data, drawing on institutional reports, policy documents, and peer-reviewed academic literature. The approach is not a methodological compromise but a deliberate adaptation to the available evidence base — one that makes it possible to map the structure of the problem at sector level and to identify the policy mechanisms most likely to shift outcomes, even in the absence of firm-level survey data (Cozniuc, 2023, p. 165).

The sources used in this analysis were not assembled exhaustively. Three selection criteria guided the process: whether a source has direct institutional standing in the Moldovan or EU digital policy context; whether it covers the period from 2019 onwards, given that pre-pandemic data on digital adoption increasingly misrepresents current market conditions; and whether it speaks specifically to SME digitalization or cross-border e-commerce rather than to the broader digital economy in aggregate. The AmCham Moldova market reports (2024, 2025) satisfy all three criteria and remain the most detailed quantitative source on Moldova's domestic e-commerce market. For regional comparison and benchmarking against EU standards, the OECD SME Policy Index for Eastern Partner Countries (OECD et al., 2024) provides a standardized assessment across twelve policy dimensions, including — for the first time in its 2024 edition — a dedicated analysis of SME digitalization policy. Eurostat's annual survey on ICT usage and e-commerce in enterprises (2024) supplies the EU-level comparators: the Digital Intensity Index and the share of enterprises conducting e-sales, broken down by firm size. For the regulatory and technical dimensions specific to Moldova's EU integration context, the EU4Digital Facility's eCommerce harmonization recommendations (EU4Digital Facility, 2021) and the Economic Council's Digital Economy and E-commerce Roadmap (Economic Council of the Republic of Moldova, 2024) provide the primary reference documents.

The analysis is organized around four dimensions of digital readiness. The choice of this framework reflects a conceptual position developed in Section 1: that digital readiness is not a binary condition determined by access to technology, but an organizational capacity that must be assessed across multiple interdependent domains. A firm may have a functioning website and still be structurally unprepared for cross-border sales if it cannot process advance payments, fulfil orders reliably, or communicate its return policy in a foreign language. The four dimensions — technological, organizational, market access, and regulatory — are designed to capture this breadth. Table 1 sets out the indicators used to assess each dimension, their operational definitions, and their relevance to cross-border e-commerce performance.

Table 1. Digital Readiness Framework: Dimensions, Indicators and Relevance to Cross-Border E-Commerce

Dimension	Indicators	Operational definition	Relevance to CBEC
D1. Technological Readiness	– Online payment adoption (upfront) – WMS integration rate – Share of SMEs with functional e-commerce platform – Broadband penetration – Real-time inventory management	Capacity to conduct digital transactions reliably: process online payments, maintain accurate stock data, and operate a functional sales channel accessible to foreign consumers.	Upfront payment and real-time stock visibility are minimum requirements for EU marketplace participation; their absence generates order cancellations and reputational penalties.
D2. Organizational Readiness	– Share of SME staff with digital business skills – Participation in digital export training – Knowledge of EU consumer rights (14-day withdrawal) – Multilingual product content capacity – Use of digital marketing tools (Meta Ads, Google Shopping)	Availability of human capital capable of managing cross-border digital operations: platform onboarding, digital advertising, multilingual communication, and EU trade compliance.	Digital skills are the primary mediator between platform access and export performance; deficits compound as competitors accumulate platform ratings and customer relationship capital.
D3. Market Access Readiness	– International logistics cost as % of transaction value – Availability of consolidated cross-border shipping – Share of SMEs registered on EU marketplaces – Per capita cross-border online spending (€) – Average delivery time to EU markets (days)	Operational capacity to fulfil cross-border orders at competitive cost and speed: international shipping infrastructure, marketplace access, and price competitiveness relative to EU-based sellers.	For SMEs selling goods below €40, shipping costs may represent 40–60% of transaction value, rendering CBEC economically nonviable without logistics solutions or pre-positioned EU inventory.
D4. Regulatory Readiness	– Legislative alignment with EU e-commerce directives	Degree to which Moldovan SMEs can operate in compliance with EU consumer protection, data	Formal legislative harmonization and operational compliance are distinct achievements;

Dimension	Indicators	Operational definition	Relevance to CBEC
	– GDPR operational compliance – Electronic signature acceptance by legal entities – VAT OSS registration awareness and uptake – eKYC availability for business account opening	protection, and fiscal law — both at the legislative level and in firm-level operational implementation.	EU marketplace standards require SMEs to implement compliant checkout, return, and data processing procedures.

Source: AmCham Moldova (2024, 2025); OECD, ETF, EBRD & European Union (2024); Eurostat, *ICT usage and e-commerce in enterprises survey* (isoc_ec_esels, isoc_sk_dskl_i21, 2024); EU4Digital Facility (2021); Economic Council of the Republic of Moldova (2023, 2024); Ministry of Economic Development and Digitalization of the Republic of Moldova (2023).

Note: CBEC = cross-border e-commerce. WMS = warehouse management system. OSS = One Stop Shop (EU VAT regime). Indicators are assessed qualitatively against available secondary data, given the absence of firm-level survey data disaggregated for Moldovan SMEs engaged in cross-border digital trade.

Where the analysis draws comparisons beyond Moldova, it focuses on Georgia and Ukraine. The choice is not arbitrary. All three countries applied for EU membership in 2022, and all three had already been operating under Association Agreements and DCFTAs with the EU for several years before that — a shared institutional trajectory that makes cross-country comparison meaningful rather than merely convenient. They also appear together in the OECD SME Policy Index (2024), which means that digitalization policy scores can be compared across the same twelve dimensions and the same methodological framework. Georgia is particularly relevant as a comparator because its enterprise digitalization profile is somewhat more developed than Moldova's, making it useful for identifying what a near-term achievable benchmark might look like rather than an aspirational EU-level target. Ukraine's inclusion is analytically important despite the obvious disruption caused by the full-scale Russian invasion since February 2022: its pre-war trajectory offers a reference point, and the war-related acceleration of digital adoption — documented by the OECD (2024) — generates policy lessons about how crisis conditions can shift digital readiness rapidly when institutional support is present.

Two limitations deserve explicit acknowledgement. First, because the available data describes market dynamics in aggregate rather than firm behavior specifically, several of the indicators in Table 1 are assessed through proxy measures — order cancellation rates as a proxy for WMS adoption, for instance, or market-level e-commerce penetration as a proxy for SME cross-border participation. These are reasonable inferences but they carry inferential risk, and the analysis flags where they are in use. Second, the indicators in Table 1 represent what future empirical research should measure directly at the firm level; they are not all directly measurable from existing secondary sources. The framework therefore serves a dual purpose: it structures the current qualitative analysis, and it functions as an instrument design template for the primary survey research that this article calls for in its conclusions.

Conceptual Framework: Digital Readiness and Cross-Border E-commerce

Digital readiness refers to the capacity of firms to adopt, integrate, and use digital technologies in ways that improve business performance. In the context of cross-border e-commerce, digital readiness encompasses several interdependent elements: functional online sales channels, secure digital payments, inventory and warehouse management systems, digital marketing skills, export logistics, customer service infrastructure, data protection compliance, and knowledge of foreign consumer expectations and legal frameworks. This broader understanding is analytically important because the

mere existence of an online shop does not imply readiness for cross-border sales (Moroi, 2024, p. 67). A company may have a website but lack online payment integration, real-time stock visibility, multilingual product descriptions, return policies compliant with EU consumer law, or reliable international delivery partners. Therefore, digital readiness must be assessed as a business capability set, not only as a technological condition.

The resource-based view (RBV) of the firm provides the theoretical foundation for this analysis. Under the RBV, competitive advantage depends on the firm's ability to develop and combine valuable, rare, and difficult-to-imitate resources and capabilities (Barney, 1991, pp. 105–106). In cross-border e-commerce, these capabilities include IT systems, international marketing knowledge, and export operations management. Cassia and Magno (2022, pp. 276–278) operationalize this framework empirically and find that IT, international marketing, and export operations capabilities have differential effects on strategic and financial e-commerce performance. Importantly, the use of third-party e-commerce platforms partially reduces the direct importance of internal IT capabilities for financial outcomes, suggesting a modular pathway for capability development (Cassia and Magno, 2022, p. 278). This finding is particularly relevant for Moldovan SMEs, many of which lack advanced internal digital infrastructure but may partially compensate through marketplace participation and outsourced logistics.

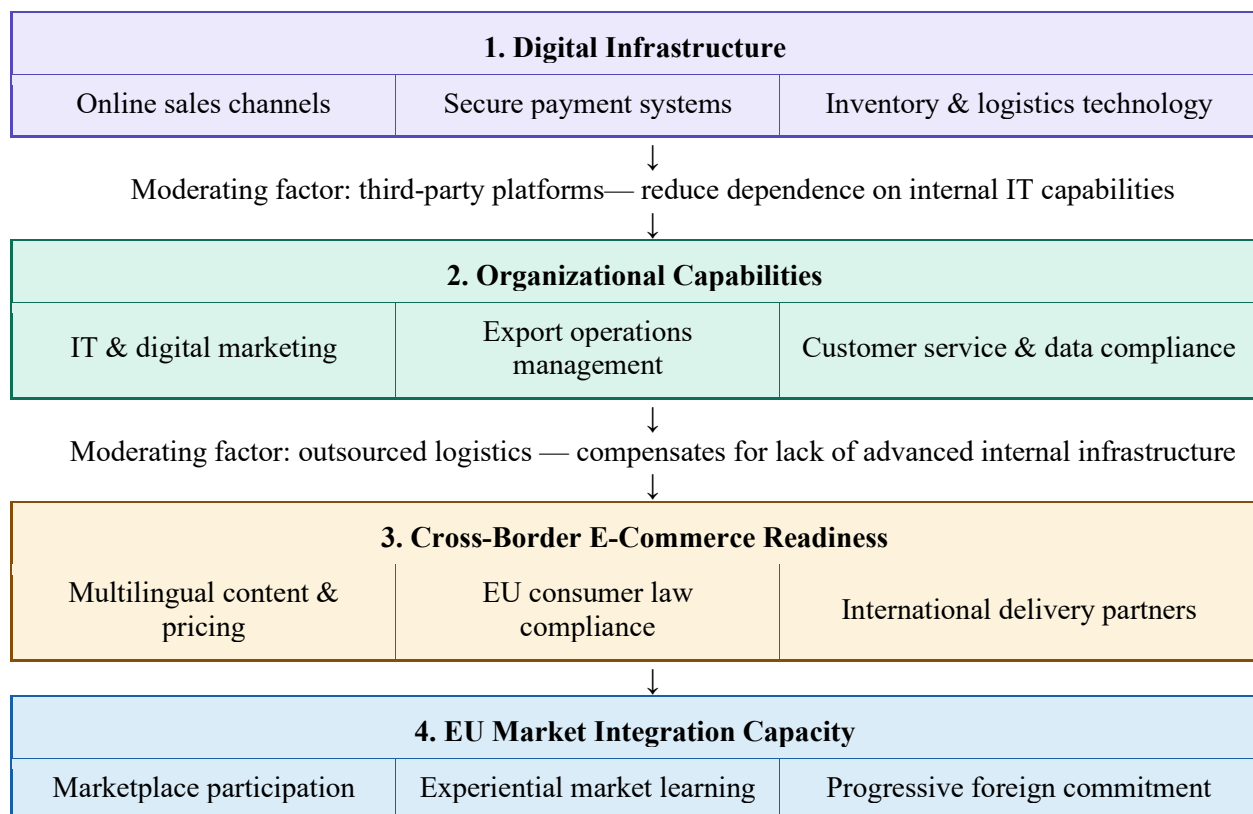


Figure 1. Digital Readiness and EU Market Integration of Moldovan SMEs through Cross-Border E-Commerce

Source: compiled by the author based on the academic literature (Moroi, 2024; Cozniuc, 2023)

A complementary perspective is offered by the internationalization process literature, particularly the Uppsala model's later formulations, which emphasize network relationships and experiential learning as drivers of progressive foreign market commitment (Johanson and Vahlne, 2009, pp. 1424–1426). Cross-border e-commerce creates an accelerated and lower-cost pathway for such experiential learning: an SME that sells to Romanian or Polish consumers through an EU marketplace gains

market knowledge that can inform subsequent product adaptation, pricing, and communication strategies. This dynamic aspect of digital readiness — its progressive accumulation through export experience — is often neglected in policy frameworks that treat readiness as a static precondition rather than an evolving capability (Cozniuc, 2023, p. 170).

Moldovan SMEs: Structural Context and E-commerce Engagement

SMEs constitute the backbone of the Moldovan economy, accounting for the large majority of registered enterprises and a significant share of employment. However, their international competitiveness remains limited by persistent structural constraints: small domestic market, low capitalization, limited managerial capacity, and weak integration into EU value chains (Cozniuc, 2023, pp. 164–166). The Association Agreement and DCFTA with the EU, in force since 2016, created a formal trade liberalization framework, but its translation into actual export growth has been uneven across sectors and firm types.

In the e-commerce domain, the available data describes overall market dynamics rather than SME-specific performance, which is itself a reflection of the limited firm-level monitoring of digital trade. The 2024 AmCham Moldova report estimates that online sales of tangible products and commercial services reached EUR 358.6 million excluding VAT in 2023, representing a 15.2% year-on-year increase, with approximately 470–520 active online shops selling tangible goods (AmCham Moldova, 2024, p. 4). This growth rate is significant, but the base remains modest and the market is heavily concentrated in Chisinau.

A critical structural feature of the Moldovan e-commerce ecosystem is its asymmetry: domestic platforms are growing, but inbound cross-border e-commerce from foreign platforms — particularly Temu and other Chinese marketplaces — is expanding even faster (AmCham Moldova, 2024, p. 7). This competitive pressure from foreign platforms is directly relevant to the discussion of SME export readiness. Moldovan SMEs are simultaneously being exposed to the operational standards of foreign e-commerce operators (as suppliers or observers) and facing increased competitive pressure in domestic niches. Whether this exposure translates into capability development or merely into market displacement is an empirical question that existing data cannot fully resolve (Moroi, 2024, p. 68).

E-commerce in Moldova still represents a modest share of domestic trade — approximately 4 to 6 percent, compared with a world average above 19 percent and significantly higher levels in more advanced European markets (AmCham Moldova, 2024, p. 5). The annual online purchase volume per capita remains well below the EU average. These figures indicate that Moldova's e-commerce sector is growing from a low base, and that the organizational and institutional preconditions for a significant expansion of cross-border export e-commerce are not yet fully in place (Bădăraș, 2019, pp. 102–103).

Main Barriers to Digital Readiness Among Moldovan SMEs

Analysis of the available evidence identifies four principal barriers to the digital readiness of Moldovan SMEs for cross-border e-commerce. These barriers are interconnected and mutually reinforcing, which implies that addressing any one in isolation is unlikely to produce substantial gains in export e-commerce performance.

Limited Online Payment Adoption and Consumer Trust

The first and most immediately visible barrier is the limited use of online payments and the persistence of cash or card payment on delivery. The 2024 AmCham Moldova report identifies this as a defining structural feature of the Moldovan e-commerce market: online payments for goods bought through e-shops are not yet common practice, which prevents the use of aggregated banking data for accurate market valuation and limits the scalability of online retail operations (AmCham Moldova, 2024, p. 9). This payment pattern reflects deeper problems of trust and operational reliability. Moldovan consumers frequently prefer to pay only after receiving and checking the product, a behavior linked to stock availability problems, inaccurate product information, and weak refund confidence (AmCham Moldova, 2024, p. 11). Critically, approximately 70 percent of suppliers

registered on marketplaces do not have functional warehouse management systems that update product availability in real time, which results in 10 to 30 percent of online orders being cancelled due to missing stock updates (AmCham Moldova, 2024, p. 12).

For cross-border e-commerce directed at EU consumers, these weaknesses are compounding rather than merely additive. EU consumers expect transparent pricing, secure upfront payment, accurate stock information, clear delivery terms, statutory return rights, and predictable customer support (European Commission, 2026). A Moldovan SME that cannot manage domestic online orders reliably is structurally disadvantaged in competing for EU consumers, where platform requirements and consumer protection standards are materially stricter and where reputational penalties for poor service propagate rapidly through review systems.

Insufficient Digital Business Skills

The second barrier is the limited level of digital business skills within Moldovan SMEs. OECD analysis of Moldova emphasizes that digital skills are cross-cutting and require coordinated policy responses involving education, labor market measures, innovation support, and private-sector participation (OECD, 2023). For SMEs seeking to enter EU e-commerce markets, this means that digital readiness is not primarily a technical procurement question. Managers and employees must understand online customer acquisition, platform algorithm dynamics, digital advertising (including EU-specific platforms such as Meta and Google Shopping), cybersecurity, data analytics, electronic invoicing, online dispute resolution, and export documentation.

The skills gap is particularly acute at the intersection of digital competence and international trade knowledge (Cozniuc, 2023, pp. 168–169). Selling to an EU consumer through a marketplace requires understanding not only how to list a product, but also how to price competitively in a foreign market, how to handle returns under EU consumer rights directives, how to manage VAT obligations across jurisdictions, and how to communicate effectively in the target language. These compound skill requirements exceed what generic digital literacy programs can address, and they point to the need for export-oriented digital training that is currently absent from the Moldovan SME support ecosystem.

Logistics and Fulfillment Fragmentation

The third barrier is the fragmentation of logistics and fulfillment infrastructure for cross-border operations. Moldova's domestic e-commerce growth has been partly driven by the expansion of last-mile delivery companies operating within the country (AmCham Moldova, 2024, p. 15). However, domestic delivery development does not automatically solve cross-border fulfillment challenges. Cross-border e-commerce requires reliable international delivery with customs integration, competitive shipping rates, parcel tracking, and efficient returns management — all at a cost structure that allows Moldovan SMEs to offer prices competitive with EU-based sellers (EU4Digital, 2026).

The geography and transit infrastructure of Moldova create additional challenges. As a landlocked country dependent on road transit through Romania and Ukraine (the latter being disrupted since 2022), shipping times and costs to major EU markets are less predictable than for sellers located within the EU customs area. For SMEs selling lower-value goods where shipping costs represent a significant share of the product price, this structural disadvantage may render cross-border e-commerce economically unviable without access to consolidated logistics solutions or warehousing partnerships in Romania.

Incomplete Regulatory and Institutional Implementation

The fourth barrier is the incomplete implementation of the digital institutional infrastructure that cross-border e-commerce depends on. The Digital Economy and E-commerce Roadmap of the Economic Council includes actions related to payment services, digital tools, electronic signatures, eKYC, and the modernization of business-government interactions (Economic Council of the Republic of Moldova, 2024). However, some digitalization measures remain partially realized:

electronically signed documents are not always accepted by legal entities, and in-person attendance is sometimes still required for administrative procedures that should be fully digital (Economic Council of the Republic of Moldova, 2023).

This institutional incompleteness creates friction costs that disproportionately affect SMEs, which lack the legal and administrative resources of larger firms to navigate complex or inconsistent procedures. For cross-border e-commerce specifically, incomplete digital identity infrastructure and limited acceptance of electronic signatures complicate the registration on foreign platforms, the conclusion of digital contracts with logistics partners, and the management of EU VAT compliance through digital systems.

EU Market Integration and Regulatory Alignment

EU market integration through e-commerce requires alignment with the rules and expectations of the EU digital market. The European Commission's e-commerce framework imposes consumer rights obligations, transparency requirements for online marketplaces, rules on digital contracts, mandatory cancellation rights, and compliance with the Digital Services Act and Digital Markets Act (European Commission, 2023). The DSA in particular introduces tiered obligations for online intermediaries that may affect Moldovan SMEs selling through EU-based platforms or operating their own online shops directed at EU consumers.

Moldova has taken steps toward legislative harmonization. National e-commerce legislation has been updated in accordance with the European model, including amendments related to domestic trade, e-commerce concepts, notification procedures, business units without commercial premises, information society services, and personal data protection (Economic Council of the Republic of Moldova, 2023). EU4Digital has developed specific recommendations for harmonizing e-commerce frameworks between Eastern Partnership countries and the EU, focusing on ecosystem development, legal framework alignment, and technical standards (EU4Digital, 2026). These are meaningful institutional advances that create a foundation for further integration.

However, formal legislative harmonization and operational firm-level compliance are distinct achievements, and the gap between them is where SME e-commerce readiness is actually tested (Bădăraș, 2019, p. 104). A law may define the concept of an electronic contract or codify consumer cancellation rights, but an SME must still implement compliant checkout procedures, secure data processing, transparent consumer communication in the target language, and reliable post-sale service including cross-border returns. The conversion of regulatory alignment into firm-level operational readiness requires not only legal reform but also implementation support, advisory services, and practical digital tools that remain underdeveloped in the Moldovan SME support ecosystem (Cozniuc, 2023, p. 172).

A comparative perspective reinforces this point. Georgia and Ukraine, which have also pursued EU Association Agreements and DCFTA frameworks, offer partial analogues for Moldova's trajectory. In both cases, formal regulatory alignment preceded widespread SME e-commerce export activity by several years, and the gap was closed primarily through targeted export digitalization programs, marketplace access facilitation, and logistics infrastructure investments rather than through legislative reform alone. Moldova's EU candidacy status creates a more direct institutional pathway, but the organizational translation of that pathway remains contingent on firm-level capability development (Ministry of Economic Development and Digitalization of the Republic of Moldova, 2023).

Cross-Border E-commerce as a Pathway for Moldovan SMEs

Despite the constraints identified above, cross-border e-commerce offers a strategically realistic pathway for Moldovan SME internationalization, subject to important qualifications about sequencing and capability prerequisites. Four mechanisms are particularly relevant.

First, cross-border e-commerce reduces the upfront cost of EU market entry. SMEs can test demand in EU markets through online channels before committing to physical distribution networks, permanent representation, or costly market research (Johanson and Vahlne, 2009, p. 1416). This is

particularly important for firms with limited capital and limited prior export experience. The data-generating properties of e-commerce — conversion rates, search patterns, geographic demand variation, price sensitivity — provide low-cost market intelligence that can inform subsequent internationalization decisions.

Second, cross-border e-commerce enables direct positioning in niche markets. Moldovan producers in sectors such as food products with regional specificity (wine, traditional foods), textiles, artisanal goods, cosmetics, or digital services may benefit from direct online positioning if they can build credible brand identities and meet EU regulatory requirements (Bădăraș, 2019, pp. 100–101). The long-tail structure of EU e-commerce markets creates spaces for differentiated offerings that would struggle to achieve sufficient scale through traditional retail channels.

Third, participation in third-party EU marketplaces can partially substitute for internal digital infrastructure investment. As Cassia and Magno (2022, p. 278) demonstrate, platform use reduces the direct impact of internal IT capabilities on financial performance, which is significant for Moldovan SMEs that may lack the resources to build proprietary e-commerce infrastructure. Platforms such as Amazon.de, eMAG, or Etsy provide logistics integration, payment processing, and consumer trust that individual SMEs cannot replicate independently. The strategic risk of platform dependence — including fee structures, algorithm changes, and listing control — must be weighed against the capability access that platform participation provides.

Fourth, cross-border e-commerce can drive organizational modernization through competitive pressure (Moroi, 2024, pp. 69–70). To sell online across EU borders, SMEs must improve product data quality, inventory management, payment integration, customer communication, and logistics reliability. These operational improvements are transferable and can increase competitiveness in domestic markets and in offline export channels simultaneously.

The pathway is, however, not automatic. Cross-border e-commerce does not eliminate the need for capabilities; it transforms their structure and raises their complexity (Cassia and Magno, 2022, p. 280). Instead of relying on physical distribution, firms must manage digital visibility, platform dependence, online reputation, delivery reliability, payment security, and multilingual regulatory compliance. Academic literature confirms that cross-border e-commerce should be approached strategically and with a medium-term planning horizon, because performance depends on the progressive development of appropriate capabilities rather than on a single investment in digital tools.

Policy Implications and Recommendations

The analysis generates six policy implications, organized from the most immediate operational priorities to the broader institutional framework.

The first and most important implication is that Moldova should reframe SME digital readiness as an export competitiveness issue rather than a general digitalization objective. Existing strategies recognize the importance of digital transformation and ICT competitiveness, but their operational translation into export-oriented e-commerce support remains weak (Ministry of Economic Development and Digitalization of the Republic of Moldova, 2023). A dedicated policy package for export-oriented SME e-commerce readiness — distinct from general digitalization programs — would create a more coherent and measurable intervention framework.

Second, training and capacity-building programs should be redesigned around practical export e-commerce tasks (OECD, 2023; Cozniuc, 2023, p. 173). Priority content areas should include: marketplace onboarding procedures for EU platforms; EU consumer rights implementation (right of withdrawal, returns, complaints); cross-border VAT and customs basics for low-value shipments under the EU's One Stop Shop regime; digital advertising on EU-dominant platforms; online payment integration; cybersecurity for small sellers; and multilingual product content standards. Generic digital literacy programs are useful but insufficient for firms that want to sell into EU markets within a medium-term horizon.

Third, the trust and payment infrastructure must be strengthened. Wider adoption of online payment methods, broader acceptance of electronic signatures, implementation of eKYC for business registration, and expansion of secure digital identity mechanisms would reduce friction in both domestic and cross-border commerce (Economic Council of the Republic of Moldova, 2024). The Digital Economy and E-commerce Roadmap already identifies these as priorities; the policy challenge is implementation pace and SME-specific outreach.

Fourth, inventory and warehouse management system adoption should be supported through targeted incentives for SMEs. The high rate of order cancellation caused by poor stock visibility — 10 to 30 percent of marketplace orders by current estimates — is both a consumer trust problem and a competitiveness problem (AmCham Moldova, 2024, p. 12). Cross-border e-commerce at EU standard cannot tolerate this level of fulfillment failure, and addressing it requires investment in operational systems, not only in customer-facing digital presence.

Fifth, Moldova should develop structured partnerships with logistics providers and EU-accessible marketplaces that can offer preferential terms or integration support for Moldovan SMEs (EU4Digital, 2026.). For many small firms, the costs of establishing cross-border fulfillment independently are prohibitive. A government-facilitated or industry-association-coordinated logistics access program — analogous to arrangements developed in Georgia and Romania for their respective SME sectors — could significantly lower the practical barriers to entry.

Sixth, regulatory harmonization must be accompanied by systematic implementation support (EU4Digital, 2026; Economic Council of the Republic of Moldova, 2023). SMEs need standardized templates, advisory services, and digital tools that translate legal requirements into operational procedures. EU-compliant legislation will have limited impact on SME export behavior if firms lack the practical knowledge to operationalize compliance requirements in areas such as data protection, consumer communication, and electronic invoicing.

Conclusions

The digital readiness of Moldovan SMEs is a decisive condition for transforming cross-border e-commerce into a genuine pathway toward EU market integration. Moldova has made meaningful progress in e-commerce development, digital policy formulation, and legislative harmonization since 2016 (Bădăraș, 2019, p. 99; Economic Council of the Republic of Moldova, 2023). The market is growing, the number of online platforms has expanded significantly, and the government has adopted strategic documents that connect digital transformation explicitly with EU integration objectives (Ministry of Economic Development and Digitalization of the Republic of Moldova, 2023).

At the same time, the current level of SME readiness for cross-border export e-commerce remains uneven and insufficient relative to EU market requirements (AmCham Moldova, 2024; Moroi, 2024; Cozniuc, 2023). The principal weaknesses are organizational and institutional rather than narrowly technological: limited online payment adoption, weak inventory management, low consumer trust, insufficient export-oriented digital business skills, logistics fragmentation, and incomplete implementation of digital institutional infrastructure. These barriers interact and reinforce each other, which implies that small and fragmented interventions are unlikely to produce the capability required for sustained cross-border e-commerce performance in EU markets.

The central conclusion of the article is that cross-border e-commerce should not be treated as a simple digital extension of domestic online retail. It constitutes a more demanding form of internationalization that requires firms to combine digital tools with export capabilities, regulatory compliance, and customer-oriented operational systems calibrated to EU standards (Cassia and Magno, 2022, p. 280; Johanson and Vahlne, 2009, p. 1428). For Moldova, the strategic priority should be the creation of an integrated SME e-commerce readiness framework explicitly oriented toward EU market access, distinct from broader digitalization programs and anchored in firm-level capability development rather than in legislative reform alone.

This article is subject to the limitation of reliance on secondary data, which constrains the specificity of conclusions about SME behavior. Future research should assess Moldovan SMEs directly through empirical indicators such as cross-border platform registration rates, online payment adoption, digital marketing capacity, logistics readiness, multilingual communication, EU compliance awareness, and actual cross-border sales performance. Comparative research with other EU Eastern Partnership candidates — particularly Georgia and Ukraine — could provide additional analytical traction on the determinants of successful e-commerce-led internationalization from similar institutional starting points.

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A FRAMEWORK FOR UNDERSTANDING CLIMATE–LABOR INTERACTIONS

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Abstract: *This paper develops a theoretical framework to explain the interactions between climate change and labor systems, building on previous research focused on the primary sector. While existing studies have examined the economic and environmental impacts of climate change, there is still a lack of theoretical integration explaining how these effects translate into labor dynamics.*

The aim of this study is to construct a conceptual model that systematizes the mechanisms linking climate variables with labor outcomes. The framework is based on an interdisciplinary literature review, incorporating perspectives from labor economics, environmental economics, and social vulnerability theory.

The analysis identifies three key channels of interaction: direct effects (such as productivity loss due to climate conditions), indirect effects (including migration and sectoral shifts), and mediated effects shaped by institutional and socio-economic factors. Additionally, the framework incorporates feedback loops, highlighting that labor systems not only respond to climate change but also influence environmental outcomes through production structures and adaptation strategies.

The findings suggest that climate–labor interactions are dynamic, non-linear, and context-dependent. This theoretical contribution provides a structured foundation for future empirical research and strengthens the analytical coherence of models examining labor dynamics under climate stress.

Key words: *Climate change; Labor systems; Theoretical framework; Productivity; Adaptation*

JEL: Q54, J21, J24, J81

Introduction

The relationship between climate change and labor systems has become increasingly relevant in both academic and policy debates. However, despite the growing body of empirical evidence, the theoretical understanding of how climate dynamics translate into labor outcomes remains fragmented and insufficiently integrated.

Most existing studies approach climate change either from an environmental perspective—focusing on physical and ecological impacts—or from an economic perspective, emphasizing productivity losses and macroeconomic effects. While these contributions are valuable, they tend to treat labor as a secondary outcome rather than as a central analytical dimension. As a result, the mechanisms through which climate variables affect labor systems are often assumed rather than explicitly theorized.

Empirical evidence demonstrates that temperature increases and climate variability have significant effects on economic performance and productivity (Burke et al., 2015; Dell et al., 2012). However, these studies do not fully capture how such effects propagate through labor markets, influence worker behavior, or reshape employment structures over time. Similarly, research on climate-induced migration and sectoral shifts provides insights into labor mobility but lacks integration within a broader conceptual framework (Mueller et al., 2014; World Bank, 2021).

This lack of theoretical integration creates an important gap. Without a structured framework, it becomes difficult to understand the full complexity of climate–labor interactions, particularly their

dynamic and multi-level nature. Moreover, policy responses risk being reactive and fragmented, addressing isolated symptoms rather than underlying mechanisms.

Building on previous research focused on the primary sector, which identified climate change, public policies, and operational efficiency as key drivers of labor dynamics, this paper aims to provide the missing theoretical foundation. Specifically, it seeks to explain not only whether climate change affects labor systems, but how and through which mechanisms these effects occur.

The objective of this paper is therefore to develop a comprehensive theoretical framework that captures the interactions between climate change and labor systems. This involves:

- (i) identifying direct and indirect transmission channels,
- (ii) incorporating mediating institutional and socio-economic factors, and
- (iii) conceptualizing feedback loops that reflect the bidirectional nature of the relationship.

By doing so, this study contributes to bridging the gap between environmental economics and labor economics, offering a more integrated perspective that can support both empirical research and policy design.

Basic content

Climate Change as a Structural Shock

Climate change can be conceptualized as a structural and persistent shock that affects economic systems in a fundamentally different way compared to traditional cyclical fluctuations. Unlike short-term economic shocks, climate-related disruptions accumulate over time and generate long-lasting transformations in production systems and labor dynamics (Stern, 2007; IPCC, 2022).

From a theoretical standpoint, climate change alters the fundamental conditions under which economic activity takes place. Changes in temperature, precipitation patterns, and the frequency of extreme events directly affect the availability and productivity of natural resources. In sectors that rely heavily on environmental conditions, such as agriculture, these changes translate into variations in output, input use, and labor demand (Mendelsohn et al., 1994; Fuglie, 2018).

Beyond resource availability, climate change also introduces increased uncertainty into economic decision-making. Firms and workers must operate under more volatile conditions, where production outcomes become less predictable. This uncertainty affects investment decisions, hiring strategies, and long-term planning, leading to more cautious behavior and, in some cases, reduced labor demand. Moreover, the cumulative nature of climate shocks implies that their effects are not isolated but compound over time. Repeated exposure to extreme events can erode productive capacity, weaken local economies, and generate persistent labor market distortions. This dynamic reinforces the idea that climate change should be understood not as a one-time shock, but as a continuous process of structural transformation.

This perspective positions climate change not merely as an external disturbance but as a structural driver of economic reconfiguration. As such, its effects on labor systems must be understood within a broader context of systemic transformation, where environmental, economic, and social processes are deeply interconnected.

Direct Transmission Mechanisms

At the first level of analysis, climate change affects labor systems through direct mechanisms related to productivity and health.

Rising temperatures have been shown to reduce worker productivity, particularly in physically demanding occupations. This effect is non-linear, with productivity losses becoming more pronounced at higher temperature thresholds (Burke et al., 2015). Similarly, climate variability has been associated with declines in economic output, especially in regions already exposed to high temperatures (Dell et al., 2012).

These productivity effects are not evenly distributed across sectors. Outdoor and labor-intensive activities—such as agriculture, construction, and fisheries—are particularly vulnerable, while more

capital-intensive or indoor sectors may be less directly affected. This creates asymmetries in labor market outcomes, contributing to sectoral imbalances.

In addition to productivity effects, climate change also impacts labor through health-related channels. Increased exposure to heat stress, air pollution, and extreme weather conditions leads to higher rates of illness, fatigue, and mortality (Deschênes and Greenstone, 2011). These factors reduce effective labor supply and increase absenteeism, further amplifying productivity losses.

Importantly, health impacts are not limited to physical conditions. Climate-related stressors can also affect mental health, particularly in regions experiencing repeated environmental shocks. This dimension, although less visible, can have long-term implications for labor participation and workforce stability.

Extreme weather events introduce an additional layer of disruption. Floods, droughts, and storms can damage infrastructure, interrupt production processes, and lead to temporary or permanent job losses. These effects are particularly severe in labor-intensive sectors and in regions with limited adaptive capacity (IPCC, 2022).

Taken together, these mechanisms highlight that direct climate impacts on labor operate simultaneously through multiple channels, reinforcing each other and generating compounded effects on productivity and employment.

Indirect Mechanisms: Market Adjustments

Beyond direct impacts, climate change induces indirect effects that reshape labor markets through structural transformation.

One of the most significant mechanisms is migration. Environmental degradation reduces local economic opportunities, particularly in rural and climate-sensitive regions. As a result, workers are forced to relocate in search of alternative livelihoods. Empirical evidence shows that heat stress significantly increases migration patterns, especially over the long term (Mueller et al., 2014). Broader analyses confirm that climate change is becoming a major driver of internal migration worldwide (World Bank, 2021).

Migration, however, is not only a response mechanism but also a source of new labor market dynamics. The inflow of workers into urban or less affected regions can generate increased competition for jobs, downward pressure on wages, and pressure on infrastructure and public services. At the same time, origin regions may experience labor shortages, particularly in sectors that depend on local knowledge and experience.

Another key mechanism is sectoral reallocation. As certain economic activities become less viable due to climate conditions, labor shifts toward other sectors. This process is not frictionless. It often involves skill mismatches, adjustment costs, and transitional unemployment, particularly in economies with limited labor mobility (Nath and Behera, 2011).

In addition, these structural adjustments may lead to long-term changes in the composition of the labor force. Workers may need to acquire new skills or transition into emerging sectors, such as renewable energy or climate-resilient industries. The speed and effectiveness of these transitions depend on education systems, training programs, and institutional support.

These indirect effects highlight that climate change does not only reduce labor productivity but also transforms the structure of labor markets, generating both risks and opportunities. Understanding these processes is essential for anticipating long-term labor dynamics.

Mediating Factors and Heterogeneity

The impact of climate change on labor systems is mediated by a set of contextual factors that determine the extent and nature of its effects.

Institutional quality plays a central role in shaping adaptive capacity. Governments can mitigate the negative impacts of climate change through policies that support labor transitions, protect workers, and promote sustainable practices (OECD, 2021). Conversely, weak institutional frameworks tend to exacerbate vulnerability and limit adaptation.

Beyond formal institutions, the effectiveness of policy implementation is equally important. Even well-designed policies may fail if administrative capacity is limited or if there is a lack of coordination between different levels of governance. This introduces variability in outcomes across countries and regions.

Income levels also influence resilience. Higher-income economies have greater access to technology, infrastructure, and financial resources, enabling more effective responses to climate shocks (Stern, 2007). In contrast, low-income regions are more exposed to risk and have fewer mechanisms for adaptation.

However, income alone does not fully determine vulnerability. Inequality within countries can lead to uneven exposure and adaptive capacity across different population groups. Workers in informal or precarious employment are often more vulnerable to climate impacts, as they lack social protection and access to resources.

Geographic conditions further shape exposure to climate risks. Regions with higher vulnerability—such as coastal areas or arid zones—experience more intense labor disruptions. This contributes to the uneven distribution of climate impacts and reinforces existing socio-economic inequalities (IPCC, 2022; Piguet et al., 2018).

Overall, these mediating factors highlight that climate–labor interactions are highly context-dependent. The same climate shock can produce very different labor outcomes depending on institutional, economic, and geographic conditions.

Feedback Loops Between Labor and Climate

A key contribution of this framework is the recognition that labor systems are not only affected by climate change but also actively influence environmental dynamics.

Labor-intensive production processes contribute to greenhouse gas emissions through energy use, resource extraction, and industrial activity. As employment expands in certain sectors—particularly those with high carbon intensity—environmental pressures may increase, reinforcing climate change and generating additional long-term risks (Stern, 2007).

However, this relationship is not unidirectional. Labor systems also play a central role in climate adaptation and mitigation processes. The reallocation of labor toward less carbon-intensive sectors, as well as the development of green jobs, can reduce environmental impact while simultaneously transforming employment structures. These transitions are often driven by both market forces and institutional interventions, highlighting the importance of policy frameworks in shaping labor–climate dynamics (OECD, 2021).

From a theoretical perspective, these interactions can be understood as dynamic feedback loops. Initial climate shocks affect labor outcomes through direct and indirect mechanisms. In response, labor systems adjust through changes in employment patterns, productivity strategies, and sectoral composition. These adjustments, in turn, influence environmental outcomes by altering emissions, resource use, and technological adoption.

This feedback process introduces a temporal dimension to climate–labor interactions. Short-term labor responses may mitigate immediate impacts but generate unintended long-term consequences if they reinforce unsustainable production patterns. Conversely, well-designed adaptation strategies can create virtuous cycles in which labor transformation contributes to both economic resilience and environmental sustainability.

Understanding these feedback loops is essential for avoiding policy approaches that focus solely on short-term labor protection without considering long-term environmental implications. Instead, an integrated perspective is required—one that recognizes labor systems as both recipients and drivers of climate dynamics.

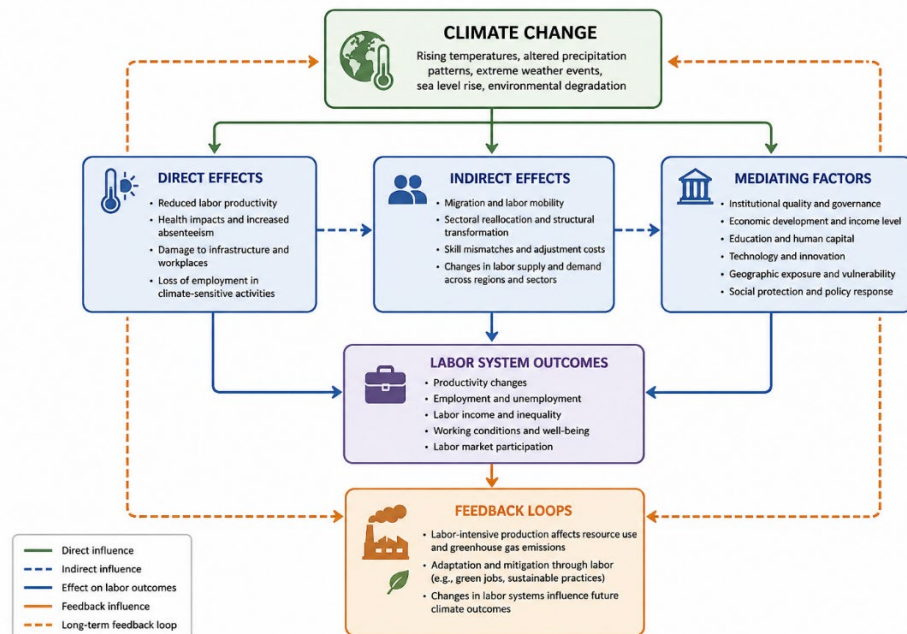


Figure 1. Conceptual Framework of Climate–Labor Interactions

Source: Own elaboration

$$L=f(C,I,S,G)$$

Where:

- L represents labor outcomes
- C climate variables
- I institutional factors
- S sectoral structure
- G geographic conditions

This functional relationship summarizes the multidimensional and interdependent nature of climate–labor interactions, emphasizing that labor outcomes are jointly determined by environmental conditions and contextual factors, rather than by climate variables alone.

Conclusions

This paper develops a theoretical framework that explains the complex and multi-layered interactions between climate change and labor systems. By integrating direct, indirect, and mediated mechanisms, as well as feedback loops, the framework provides a structured and dynamic perspective on how climate dynamics influence labor outcomes.

The main contribution of this study lies in moving beyond fragmented approaches that treat environmental and labor processes separately. Instead, it offers a unified analytical structure that captures the interdependence between climate shocks, labor market adjustments, and institutional contexts. In doing so, the framework highlights that labor systems should not be understood solely as passive recipients of climate impacts, but also as active agents shaping environmental trajectories.

Furthermore, the model introduces a dynamic perspective by incorporating feedback mechanisms, emphasizing that labor responses to climate change can either reinforce or mitigate environmental pressures. This insight has important implications for both research and policy, as it underscores the need to align labor adaptation strategies with long-term sustainability objectives.

From an empirical standpoint, the framework provides a foundation for future research aimed at testing the proposed relationships across different sectors and regional contexts. In particular, it supports the development of models that integrate climate variables, institutional factors, and labor dynamics within a unified analytical structure.

Finally, from a policy perspective, the findings suggest that effective responses to climate change must go beyond isolated interventions. Policies should simultaneously address labor protection, economic adaptation, and environmental sustainability, ensuring that short-term adjustments do not generate long-term vulnerabilities. In this sense, the framework contributes to a more coherent understanding of how to design integrated strategies that strengthen both labor resilience and climate outcomes.

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Section 2: MANAGEMENT AND MARKETING (I)

INTEGRATING ORGANIC FARMING INTO THE COMMON AGRICULTURAL POLICY: CHALLENGES AND IMPLICATIONS FOR THE REPUBLIC OF MOLDOVA

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Abstract: *Agriculture represents an essential sector of the economy, contributing to income generation, food security, and job creation for a considerable portion of the population. Against the backdrop of climate change and rising global temperatures, the growing pressures of climate change have brought the long-term viability of agricultural systems into sharper focus, highlighting the urgent need for production approaches that safeguard the environment and preserve natural resources. In this context, organic farming stands out as a key pillar of sustainable agriculture, supporting the prudent management of natural assets and the preservation of ecological balance, in line with the principles set out in Regulation (EU) 2018/848 on organic production and the labelling of organic products [10].*

Through the reduction of synthetic pesticides and fertilizers and applying agricultural practices based on natural processes, organic farming contributes to the conservation of soil fertility, biodiversity protection, and the reduction of negative environmental impacts. Simultaneously, this farming approach contributes to the provision of safe, high-quality food for consumers.

At the level of the European Union, the advancement of sustainable and organic agriculture is considered a strategic priority. Through the Common Agricultural Policy, a range of support mechanisms is implemented to encourage farmers to adopt environmentally friendly practices and to increase the area under organic cultivation. These actions are consistent with the goals set out in the European Green Deal and the Farm to Fork Strategy, which aim to reshape European food systems into more sustainable and resilient models [5].

Within this framework, organic agriculture is viewed as a production model grounded in the three pillars of sustainable development - economic, social, and environmental - thereby supporting the achievement of European Union objectives related to environmental protection, the conservation of natural resources, and the mitigation of climate change.

Key words: *organic agriculture; sustainable agriculture; Common Agricultural Policy; climate change; biodiversity protection; European Union.*

JEL: O13, Q18. Q28, Q57

Introduction

Organic farming in the Republic of Moldova is a developing sector with considerable potential for expansion, playing an important role in maintaining the health of agroecosystems, preserving biodiversity, and ensuring the sustainable use of natural resources. By reducing the use of synthetic pesticides and fertilizers and applying practices based on natural processes, this production system supports soil fertility, environmental protection, and the supply of safe and high-quality food. Currently, the country has dozens of certified operators and an increasing area of organically cultivated land.

The National Development Strategy "Moldova 2030" and the National Agricultural and Rural Development Strategy 2023–2030 explicitly include measures to promote sustainable agriculture, integrate green economy principles, and reduce environmental pressure. Policies provide incentives for adopting organic practices, aligning with European standards, and expanding organically cultivated areas. These objectives are consistent with European Union directives and strategic instruments such as the Common Agricultural Policy, the Farm to Fork Strategy, and the European Green Deal, which aim to transform food systems into sustainable and resilient models [4, 5].

The Republic of Moldova has likewise pledged to implement the United Nations 2030 Agenda for Sustainable Development, which establishes objectives related to food security, environmental protection, sustainable rural development, and adaptation to climate change. International projects and partnerships, including those supported by UNDP and GEF, have contributed to building the capacities of organic producers, promoting certified products, and informing consumers through tools such as the Atlas of Organic Producers [11].

In this sense, organic farming in the Republic of Moldova is consistent with national strategies as well as international sustainable development objectives, serving as an important tool for enhancing food security, protecting the environment, and supporting the sustainable economic growth of the agricultural sector.

Organic Farming within the Common Agricultural Policy.

Organic farming is a key component of the Common Agricultural Policy (CAP), functioning as an important tool for reaching the European Union's goals in environmental protection, sustainability, and rural development. In the context of the CAP reform for 2023 - 2027, this sector is closely connected to the priorities of the European Green Deal and the Farm to Fork Strategy, which are designed to support the shift towards more sustainable and resilient food systems (European Commission, 2021) [4].

A defining feature of organic farming within the CAP is its recognition as a high environmental value farming practice. Farmers applying organic methods comply with strict standards regarding the use of natural resources, the prohibition of synthetic chemical inputs, and the preservation of biodiversity. In this regard, organic farming directly contributes to the European Union's climate and environmental objectives (European Commission, 2023) [5].

Support for the organic sector under the CAP is structured around two main pillars. The first pillar includes direct payments and eco-schemes, which reward farmers for adopting environmentally friendly practices. Organic farming is considered "green by definition", which facilitates access to these payments and reduces administrative complexity [5]. The second pillar, dedicated to rural development, provides specific measures for conversion to organic farming, maintenance of organic practices, as well as investments in farms and value chains (European Court of Auditors, 2024) [6].

An important role is also played by the EU Action Plan for the Development of Organic Production, which sets the objective of reaching 25% of agricultural land under organic farming by 2030. This plan includes measures aimed at stimulating demand, strengthening consumer trust, and improving certification systems (European Commission, 2021) [4].

Furthermore, the CAP promotes innovation and knowledge transfer through the Agricultural Knowledge and Innovation Systems (AKIS), facilitating farmers' access to research, advisory services, and best practices. This is essential for enhancing competitiveness and adapting organic farming to climate-related challenges [6].

However, the implementation of organic farming within the CAP faces several challenges, including disparities between Member States, difficulties in assessing environmental impact, and high conversion costs for farmers. Additionally, market volatility and insufficiently developed demand may limit the expansion of this sector (European Court of Auditors, 2021) [6].

In summary, organic farming occupies a strategic role within the Common Agricultural Policy, supporting the development of a more sustainable and resilient agricultural system. Through its financial and regulatory mechanisms, the CAP promotes both the expansion of the organic sector and the wider transformation of the European Union agri-food system [4, 5, 10].

The State of Organic Farming in the Republic of Moldova.

In the Republic of Moldova, organic farming has been encouraged as a strategic priority focused not only on enhancing agricultural production, but also on changing the practices and attitudes of farmers and agricultural producers [1]. The implementation of this model is supported by a relatively well-developed legal framework, partially aligned with European standards. However, the volume of

organic agri-food production remains modest, with the main constraint being the insufficient availability of technological, financial, and research resources necessary for sector development.

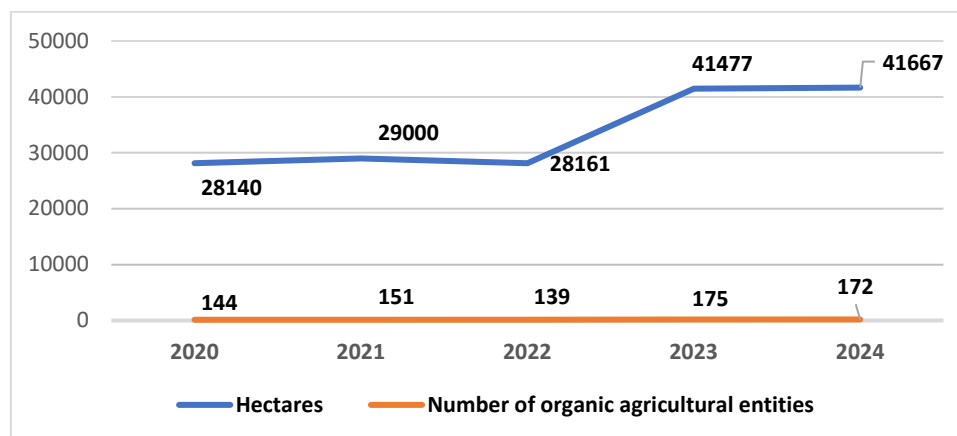
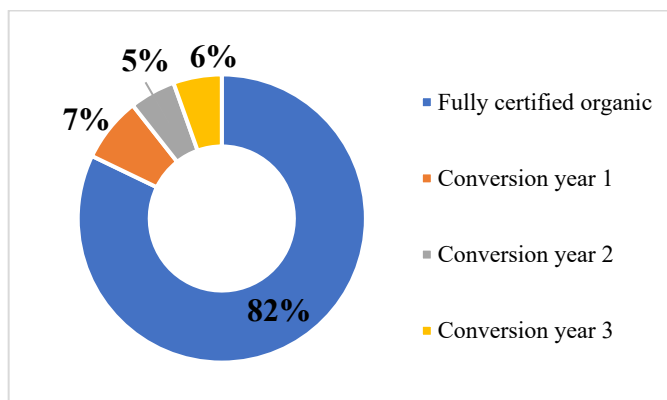


Figure 1. Area of agricultural land under the organic farming system and the number of registered organic operators

Source: www.maia.gov.md

An analysis of the sector's evolution indicates a significant increase in organically cultivated areas. During the period 2020 -2024, these expanded from 28,140 hectares to approximately 41,667 hectares, reflecting a strong upward trend. In 2024, the total area of agricultural land managed under the organic system (including land under conversion) accounts for about 1.4% of the country's total agricultural land. Compared to 2020, this area increased by approximately 42.6%, confirming the ongoing expansion of organic farming.

The structure of these areas highlights the dominance of crop production. Approximately 43% of the land is used for cereals and grain legumes, 48% for industrial crops, 8% for perennial plantations, and about 1% for other crops. In 2024, the distribution of land by certification status shows that 82% is fully certified organic, while the remaining area is under conversion (7% in the first year, 5% in the second year, and 6% in the third year).



Organic farming indicators in the Republic of Moldova for 2024 highlight the following distribution of areas:

- 41,667 hectares were fully certified as organic;
- 3,677.9 hectares were in the first year of conversion;
- 2,618.1 hectares were in the second year of conversion;
- 2,763.0 hectares were in the third year of conversion.

Figure 2. Areas registered in 2024 in organic farming

Source: Data provided by the Ministry of Agriculture and Food Industry and the Agency for Intervention and Payments in Agriculture

The sector comprises around 172 certified economic entities, either under national or international certification schemes. More than two-thirds hold certificates issued by international control bodies, enabling access to export markets, while less than one-third operate exclusively on the domestic market. The dominant activity is agricultural production (113 entities), primarily in the crop sector,

alongside a smaller number engaged in beekeeping. Other activities include organic processing (30 entities), export (19 entities), import and trade (5 entities), and the harvesting of wild flora (5 entities).

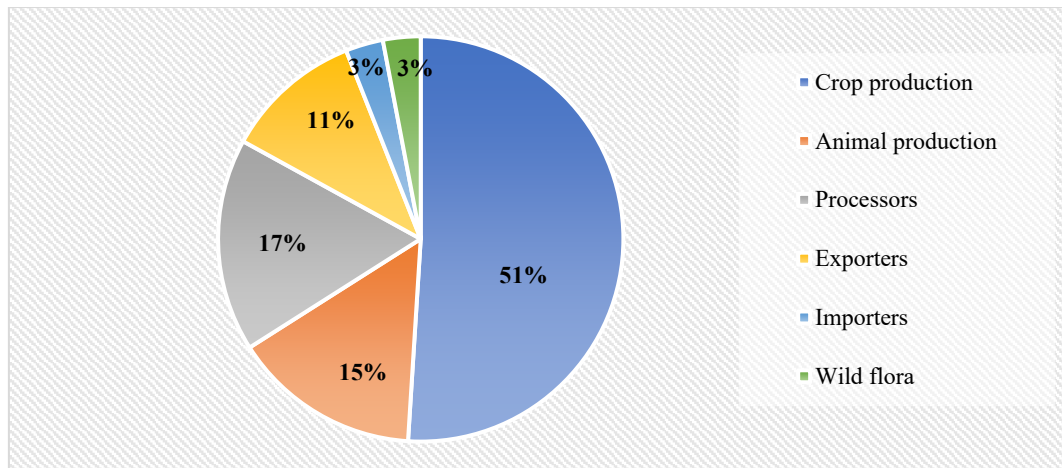


Figure 3. Types of activities in organic farming in 2024

Source: Developed by the author based on data provided by the Ministry of Agriculture and Food Industry.

A key feature of the organic sector in the Republic of Moldova is its pronounced focus on exports. More than 90% of organic production is sold on foreign markets, especially within the European Union. In this regard, Moldova is positioned 17th among exporters of organic products to the EU and is one of the main suppliers in Eastern Europe, ranking just behind Ukraine [2].

In general, organic farming in the Republic of Moldova can be regarded as undergoing a phase of accelerated development, characterized by the expansion of cultivated areas and an increasing number of operators. However, the sector remains heavily export-oriented and faces structural challenges, highlighting the need to strengthen public policies, market infrastructure, and institutional capacities in order to fully capitalize on its potential [12].

Challenges in the Integration of the Republic of Moldova into the Common Agricultural Policy (CAP).

The alignment of the Republic of Moldova with the Common Agricultural Policy of the European Union is a strategic process involving the structural transformation of the agri-food sector, with important implications for its institutional, regulatory, and economic systems. This process is complex and involves a set of interdependent challenges that influence both the pace and quality of alignment with EU standards [5].

Firstly, a key constraint is the limited administrative and institutional capacity. The implementation of CAP mechanisms requires efficient administrative structures, qualified human resources, and operational procedures aligned with EU requirements. In the Republic of Moldova, institutions responsible for agricultural policy implementation still face constraints related to inter-institutional coordination, digitalization of processes, and experience in managing EU-type financial instruments. These shortcomings may result in implementation delays and reduced policy effectiveness [5].

Another major issue is the insufficient harmonization of the national legal framework with the EU acquis. Although progress has been made in regulatory alignment, the transposition and, more importantly, the effective enforcement of EU regulations in areas such as food safety, environmental protection, animal welfare, and rural development remain incomplete. This creates discrepancies between CAP requirements and national institutional realities, affecting systemic compatibility.

At the same time, the limited absorption capacity of external funds represents a significant structural bottleneck. The lack of extensive experience in managing complex financial instruments, combined with insufficiently standardized administrative procedures, reduces the efficiency of external resource utilization. Consequently, the potential for agricultural modernization is only partially realized.

A further challenge is the structural fragmentation of agricultural holdings. The prevalence of small-scale farms limits investment capacity, market competitiveness, and compliance with EU standards regarding quality, traceability, and food safety. Within the CAP framework, such fragmentation may hinder effective access to financial support and the implementation of advanced agricultural practices. In addition, compliance with CAP environmental and climate requirements requires substantial adjustments to traditional farming practices. EU policies promote a transition toward sustainable agriculture with reduced environmental impact, which implies investments in modern technologies, efficient natural resource management, and the adoption of environmentally friendly practices. For Moldovan farmers, these adjustments may generate significant adaptation costs [4, 5].

Finally, limited access to advisory services and knowledge transfer mechanisms reduces the ability of agricultural stakeholders to quickly adapt to CAP requirements. The absence of effective agricultural extension systems contributes to low awareness of both opportunities and obligations associated with European integration.

In conclusion, the integration of the Republic of Moldova into the Common Agricultural Policy depends on addressing a range of complex structural challenges that affect the institutional, economic, and social aspects of the agricultural sector. Addressing these challenges requires coherent reforms, investments in administrative capacity, and the strengthening of agricultural governance mechanisms to ensure genuine convergence with the European Union's agricultural policy framework.

Conclusions

The analysis shows that organic farming is a key component of the Common Agricultural Policy, reflecting the strategic direction of the European Union toward sustainable agricultural development, environmental conservation, and climate change mitigation. Within this framework, organic agriculture is positioned as a key instrument for promoting resource efficiency and reducing the environmental footprint of agricultural production systems.

In the Republic of Moldova, organic farming has demonstrated a gradual development trajectory, evidenced by the expansion of certified organic land and the increasing integration of producers into export-oriented value chains. Nevertheless, the sector remains relatively underdeveloped and structurally constrained, with limited domestic market demand, insufficient processing infrastructure, and a high degree of dependence on external markets.

The present situation of organic agriculture in the Republic of Moldova reveals a twofold reality: on the one hand, significant development potential driven by favorable natural conditions and increasing international demand; on the other hand, persistent institutional, economic, and structural limitations that restrict its sustainable expansion.

The integration of organic farming into the CAP framework requires comprehensive alignment with the *acquis communautaire*, particularly in relation to certification systems, traceability mechanisms, environmental standards, and farm management requirements. This process entails substantial adjustments for national producers, many of whom face constraints in meeting the rigorous standards imposed by EU regulations.

The process of aligning the Republic of Moldova with the Common Agricultural Policy is marked by a series of structural difficulties, such as restricted administrative and institutional capacities, partial alignment of the regulatory framework, and a comparatively low absorption rate of external financial support. These issues are further intensified by weak agricultural advisory services and limited mechanisms for knowledge transfer.

Moreover, the highly fragmented nature of agricultural holdings in Moldova constitutes a major obstacle to competitiveness, reducing farmers' ability to meet CAP standards and to effectively access and utilize EU support measures.

Furthermore, compliance with CAP environmental and climate objectives necessitates profound transformations in production practices, requiring increased investment in modern technologies,

sustainable resource management, and the strengthening of innovation and education systems within the agricultural sector.

In essence, the successful integration of organic farming into the Common Agricultural Policy framework in the Republic of Moldova relies on the implementation of coherent institutional reforms, the strengthening of administrative capacities, and sustained investment in human capital and agricultural infrastructure. These measures are essential for ensuring long-term convergence with European standards and for enhancing the competitiveness and sustainability of the national agricultural sector.

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A REVIEW OF MATURITY FRAMEWORKS FOR DATA DRIVEN SOCIO-DEMOGRAPHIC POLICY MANAGEMENT

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Abstract: *This paper reviews maturity and readiness frameworks that can inform data-driven socio-demographic policy management in the Republic of Moldova. The review is motivated by Moldova's demographic decline, population ageing, migration, labour-market pressures and growing demand for social services, all of which require more anticipatory and evidence-informed policy processes. Although governments now produce and store increasing volumes of statistical, administrative and digital data, data availability does not by itself improve policy decisions. The paper examines selected frameworks from data governance, open data, digital government, artificial intelligence readiness and data-driven decision-making, including OECD, World Bank, Global Data Barometer, Open Data Maturity, DAMA/IBM-type models, DECAS and evidence-informed policymaking approaches. The review shows that these frameworks offer useful building blocks, such as data stewardship, data quality, interoperability, openness, leadership, analytical capacity, ethical safeguards and user orientation. However, most remain partial: some focus on data assets, some on digital readiness, others on openness or AI preparedness, while few assess how evidence is used across the full socio-demographic policy cycle. The paper concludes that future research should develop and empirically test an integrated maturity framework that links technical, institutional, ethical and policy-cycle dimensions before it is used as a diagnostic instrument for public institutions.*

Key words: *data-driven policy management; socio-demographic policy; maturity frameworks; data governance; digital government; evidence-informed decision-making.*

JEL: H83, J11, O33.

Introduction

The Republic of Moldova is facing a profound socio-demographic transformation that directly affects the sustainability of public services, labour markets, social protection, education, healthcare, territorial development and fiscal planning. The results of the 2024 Population and Housing Census provide an updated statistical baseline for understanding population distribution and structural demographic change, with the usually resident population estimated at 2.409 million persons as of 8 April 2024 (National Bureau of Statistics of the Republic of Moldova, 2026). The available analyses describe Moldova's demographic situation as one of the most serious challenges to the country's long-term development prospects. Calus (2025) presents the scale of depopulation and migration pressures as a strategic concern, while Gagauz (2023) highlights the expected economic and social implications of depopulation and demographic ageing by 2040. The European Commission's 2025 report on the Republic of Moldova also underlines the importance of administrative capacity, evidence-informed policymaking and the broader reform agenda linked to European integration (European Commission, 2025). In this context, socio-demographic policy management must become more data-driven, cross-sectoral and capable of using digital evidence for both strategic planning and operational decisions.

At the same time, the global public sector is undergoing a transition from digitized and digitalized administration to data-driven governance. The OECD (2019) argues that a data-driven public sector depends not only on data availability, but also on governance, leadership, skills, infrastructure and ethical safeguards. The World Development Report 2021 similarly stresses that data can create

development value only when supported by trust, safeguards and institutional capacity (World Bank, 2021). Digital transformation therefore creates an opportunity for the public institutions in Moldova, but it also raises an important question: how can public institutions ensure that data and digital systems influence policy choices, implementation monitoring and institutional learning?!

This question is especially relevant because digitalization does not automatically produce better public management. Public institutions may collect large volumes of administrative and statistical data without integrating them into problem diagnosis, policy option appraisal, budgeting, targeting, service delivery or evaluation. They may also introduce artificial intelligence (AI) or advanced analytics before data quality, interoperability, stewardship, accountability and human oversight are sufficiently mature. As Charles, Rana and Carter (2022) note, AI can strengthen governance and decision-making in public affairs, but it requires institutional arrangements that ensure responsible use, transparency and public value.

The research problem addressed in this paper is therefore the gap between the growing availability of demographic, administrative and digital data and the institutional maturity required to use such data systematically throughout the socio-demographic policy cycle. This gap is particularly important in policy fields shaped by long-term demographic change, because decisions on ageing, migration, family policy, youth, labour-market participation, territorial development and social protection require cross-sectoral evidence, forecasting capacity and institutional coordination.

The central research question is how do existing maturity and readiness frameworks address the institutional conditions required for data-driven socio-demographic policy management, and what are their main contributions and limitations.

The objective of the paper is not to present or validate a new maturity model. Instead, the paper critically reviews selected conceptual and policy frameworks that can inform the future development of a more comprehensive maturity or diagnostics framework for socio-demographic policy management. The contribution of the paper is threefold. First, it clarifies why socio-demographic policy management requires more than data availability. Second, it identifies the value and limitations of existing frameworks in the fields of data governance, open data, digital government, AI readiness and data-driven decision-making. Third, it outlines the key elements that could inform a future integrated maturity framework tailored to public institutions responsible for socio-demographic policies.

Review of relevant maturity frameworks

Methodological approach: structured desk review

The paper is based on a structured desk review of academic and policy literature relevant to data-driven socio-demographic policy management. The current review is not a systematic literature review in the strict sense, because it does not apply a complete database search protocol, formal screening procedure or bibliometric analysis. Instead, it is designed as a conceptual review that maps the main categories of maturity and readiness frameworks relevant to the research problem.

The review covers the following groups of literature and policy frameworks: (i) data-driven decision-making and decision theory; (ii) data governance and data management maturity; (iii) digital government maturity and data-driven public sector frameworks; (iv) open data, data availability and open data readiness frameworks; and (v) AI readiness and responsible digital transformation. The selection of frameworks was guided by their relevance for public institutions that need to transform demographic, administrative and digital data into policy decisions, implementation routines and learning mechanisms.

The analytical reading of the literature was organized around four questions: *What does the framework primarily measure or explain? What value does it offer for socio-demographic policy management? What are its limitations? Which elements could inform a future integrated maturity framework?*

This approach allows the paper to compare frameworks that were developed for different purposes while avoiding the premature claim that any single model can already assess the full maturity of data-driven socio-demographic policy management.

Why socio-demographic policy requires data-driven policy management

Socio-demographic policies are difficult to design and manage because they deal with gradual structural changes while also requiring concrete decisions in the short and medium term. Population decline, ageing, migration, labour shortages, changing family patterns and territorial inequalities cut across several areas of government. They influence education, social protection, healthcare, employment, housing, local development and public finance at the same time. As a result, no single institution can address them in isolation. When data systems, responsibilities and decision-making processes remain fragmented, policy responses also risk becoming fragmented.

Data-driven policy management is the institutionalized use of high-quality, interoperable, and ethically governed data, together with analysis, deliberation, and learning, to steer the full policy cycle from problem definition and targeting through option appraisal, implementation, monitoring, evaluation, and adaptation. In socio-demographic policy management, it requires cross-sector integration of population, territorial, service, and administrative data so that governments can coordinate action on complex and sensitive issues while protecting rights, trust, and equity (OECD 2020). Thus, data-driven management is broader than the production of statistics or dashboards. It concerns the institutional routines through which evidence becomes part of managerial processes, strategic planning, resource allocation, service design and accountability.

The literature on data-driven decision-making (DDDM) is useful because it stresses that data must be interpreted and translated into decisions. Mandinach (2006) describes DDDM as a cognitive and iterative process in which actors move from data to information and knowledge through collecting, organizing, analysing, summarizing, synthesizing and prioritizing. This view is valuable because it recognizes that data use depends on skills, interpretation and context. However, in public administration, cognitive data use by individuals is insufficient unless it is embedded in organizational routines, formal responsibilities, review mechanisms.

Decision analysis demonstrates that structured, data-driven processes consistently outperform intuition in complex policy settings (Borgonovo et al. 2026). Keeney's (1992) Value-Focused Thinking reveals a common flaw in institutional practice: decision-makers fixate on existing alternatives instead of clarifying the underlying values that should shape data collection and policy goals. For socio-demographic policies, this means maturity frameworks must evaluate not just data systems but whether data efforts align with outcomes that matter to citizens. The Value of Information principle (Howard 1966; Borgonovo et al. 2026) further supports prioritizing investments in data maturity, since better information cuts uncertainty and leads to more effective decisions.

Elragal and Elgendy (2024) propose a DDDM readiness assessment model grounded in the DECAS theory: a five-pillar framework encompassing the decision-maker, the decision, the decision-making process, data, and analytics. Their empirical application in a Swedish food manufacturer reveals a pattern that is likely to recur in public institutions: readiness in process and human capacity does not automatically translate into readiness in data infrastructure and analytics. This asymmetry is significant. An institution may have well-defined procedures and trained staff yet remain unable to act on data because the underlying data systems are fragmented or immature. The DECAS framework, however, was designed for corporate environments where the primary objective is firm performance. Applying it to socio-demographic policy institutions requires a fundamental reorientation from competitive advantage to public value, from customer data to population data, and from operational efficiency to policy equity and evidence-based governance.

Review of maturity and readiness frameworks

The reviewed frameworks provide important building blocks for understanding maturity, but they differ significantly in scope, level of analysis and policy relevance. Table 1 summarizes their main value and limitations for data-driven socio-demographic policy management and extract elements which could potentially inform a future integrated maturity framework.

Table 1. Analytical value and limitations of selected frameworks relevant for data-driven socio-demographic policy management

Framework / family of frameworks	What does the framework primarily measure or explain?	What value does it offer for socio-demographic policy management?	What are its limitations?	Which elements could inform a future integrated maturity framework?
DDDM and decision-theory frameworks (Simon, Mandinach et al., DECAS)	How data, decision-makers, analytics and decision processes interact.	Useful for understanding how evidence enters decision-making and why data availability is not enough.	Often not sufficiently institutionalized for public-sector policy cycles, accountability and cross-sectoral governance.	(1) a public accountability dimension measuring whether data use is transparent, auditable, and aligned with legal mandates; and (2) a cross-sectoral integration dimension assessing whether data flows across the fragmented institutional landscape typical of socio-demographic policy (social protection, health, education, labour, local development).
Data governance and data management maturity models (DAMA, IBM-type models.)	Data stewardship, quality, standards, metadata, lifecycle, security, policy and roles.	Strong foundation for ensuring that demographic and administrative data are trustworthy, reusable and managed responsibly.	Often enterprise-oriented and focused on data assets rather than policy choices, public value and democratic accountability.	Reoriented towards public data assets (population registers, administrative records, social protection databases) rather than commercial data products. A policy relevance dimension must be added: data must not only be well-managed, but actively linked to the policy questions it is meant to answer and the citizens it describes.
OECD data-driven public sector and digital government frameworks	Whole-of-government digital maturity, data as a strategic asset, government as a platform, open by default, user-driven and proactive services.	Highly relevant for national reform agendas and for aligning digital transformation with public-sector modernization.	Broad and macro-level; less precise for assessing whether socio-demographic policy decisions actually use evidence across the full cycle.	The "data as a strategic asset" principle informs a dimension assessing whether socio-demographic data is formally governed and resourced, not treated as an administrative by-product. The whole-of-government maturity logic offers a multi-level structure (national, sectoral, institutional) replicable for fragmented demographic policy governance. The "open by default" and interoperability concepts inform a cross-institutional data flow dimension. The distinction between digital readiness and digital adoption is directly applicable: institutions may have tools but lack the culture or capacity to use them, a gap the framework must diagnose.

Framework / family of frameworks	What does the framework primarily measure or explain?	What value does it offer for socio-demographic policy management?	What are its limitations?	Which elements could inform a future integrated maturity framework?
World Bank Open Data Readiness Assessment (ODRA)	Readiness to design and implement open data initiatives, including leadership, legal framework, institutional capacity, data demand and supply.	Useful for assessing whether public-sector data can be opened, reused and connected to external demand.	Primarily focused on open data ecosystems, not on internal policy management, implementation monitoring or learning routines.	The eight assessment dimensions (leadership, policy/legal framework, institutional capacity, data demand, financing, technology, data supply, partnerships) offer a replicable diagnostic structure adaptable to socio-demographic policy institutions. The legal and regulatory readiness dimension directly informs a normative compliance layer: a future framework should assess whether institutions operate within a clear legal mandate for data collection, sharing, and use. The institutional capacity dimension, covering human resources, skills, and organisational culture, is directly transferable as a maturity sub-dimension. The focus on data demand introduces a user-side perspective often absent from technical frameworks: a future model should assess whether policy decision-makers actively request and use data, not only whether data is produced.
Global Data Barometer and Open Data Maturity assessments	Benchmarking governance, capability, availability, use and impact of data and open data across countries and sectors.	Helpful for comparative benchmarking and for identifying gaps in data availability, use and public value.	Use and impact indicators remain difficult to measure; they do not fully capture how data changes policy decisions.	The five-pillar benchmarking structure (governance, capability, availability, use, impact) provides a ready-made dimensional architecture that a future integrated framework could adopt and contextualise for socio-demographic policy institutions. The distinction between data availability and data use directly motivates a dedicated dimension in a future framework: institutions may score well on supply-side indicators while remaining at early maturity stages in evidence-based policy practice.
AI readiness and responsible AI frameworks	Preparedness for AI adoption, including data, infrastructure, skills, governance, ethics and risk management.	Relevant because advanced analytics and AI can support forecasting, targeting and anticipatory governance.	Risk of focusing on technology adoption before foundational data governance, human oversight and policy accountability are mature.	The governance, ethics and risk management dimensions inform a responsible data use layer in a future framework: maturity should include whether institutions have oversight mechanisms, accountability structures, and safeguards against algorithmic bias in policy decisions.

Framework / family of frameworks	What does the framework primarily measure or explain?	What value does it offer for socio-demographic policy management?	What are its limitations?	Which elements could inform a future integrated maturity framework?
				The skills and human oversight components reinforce the need for a capacity dimension that goes beyond technical infrastructure, assessing whether staff can critically evaluate, interpret, and challenge data-driven outputs. The anticipatory governance concept, using data and models to forecast demographic trends and design proactive policy responses, can serve as the defining characteristic of the highest maturity level in a socio-demographic policy framework.
Evidence-informed policymaking and science-for-policy frameworks (Based on: Sempé, L., Pande, S., Kelly, C. et al. (2025).	Institutional capacity to mobilize, interpret and use evidence in policy processes.	Important for connecting administrative data, research, evaluation and expert knowledge to public decisions.	Often less operational on data infrastructure, interoperability, analytics capability and digital governance.	The four pathways of change: capabilities, relationships and networks, structures and processes, and evidence culture, offer a multi-dimensional diagnostic architecture directly transferable to a maturity framework: each pathway can be assessed at graduated levels, from absent to institutionalized. The four outcome domains (conceptual, attitudinal/behavioural, procedural, and content outcomes) provide a graduated results framework: a future maturity model should assess whether data use is changing how policymakers think, behave, design processes, and ultimately shape policy content.

Source: Author's synthesis based on reviewed literature and policy frameworks.

Conclusions

The review of maturity and readiness frameworks presented in this paper leads to three main conclusions.

First, no single existing framework is sufficient for assessing the institutional maturity required for data-driven socio-demographic policy management. Each framework reviewed offers genuine value: DAMA-type models provide rigorous data stewardship standards; OECD frameworks establish the normative case for data as a strategic public asset; the World Bank ODRA offers a replicable diagnostic structure; the Global Data Barometer enables cross-country benchmarking; AI readiness frameworks introduce ethical governance and anticipatory logic; and EIPM frameworks foreground the cultural and political conditions for evidence use. Yet each also has a significant limitation, they are either enterprise-oriented, macro-level, supply-side focused, or insufficiently attentive to the full socio-demographic policy cycle. The gap between data availability and institutionalized data use in policy decisions remains poorly addressed by any single framework.

Second, the elements identified across these frameworks collectively point toward the architecture of a future integrated maturity framework. Such a framework would need to combine at minimum: a data governance and quality dimension; a legal and normative compliance dimension; an institutional capacity and culture dimension; a cross-sectoral interoperability dimension; a policy-cycle integration dimension, assessing whether data enters problem diagnosis, option appraisal, implementation, monitoring and learning; and an accountability and public value dimension. The sequencing principle from AI readiness frameworks is also relevant: advanced analytics and anticipatory governance should be assessed as characteristics of higher maturity levels, not as preconditions for beginning the maturity journey.

Third, the development of such a framework requires empirical validation before it can serve as a reliable diagnostic instrument. The desk review conducted in this paper establishes the conceptual rationale and the building blocks. The next step is to design and test a measurement instrument with public institutions responsible for socio-demographic policies, beginning with the institutional context of the Republic of Moldova, where the normative mandate for data-driven governance is already reflected in laws and government decisions, but where the institutional capacity to fulfil that mandate remains at an early stage of development. This emerging context requires building institutions that know how to ask the right policy questions, identify relevant data, assess quality, interpret evidence, compare policy options, monitor implementation and learn from results. In this sense, maturity should be understood not as technological advancement alone, but as the capacity of public institutions to use data responsibly and systematically in the service of public value, social resilience and long-term demographic sustainability.

This research agenda is the subject of the author's ongoing doctoral work.

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MANAGING THE INTEGRATION OF AI INTO THE EDUCATIONAL PROCESS: PROS AND CONS IN PEDAGOGICAL WORK

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Abstract: *Today, AI tools are used more and more often in education and educational management. Educational institutions are actively introducing AI tools into teaching and administrative processes, which creates both new opportunities and new organizational challenges. AI technologies can help teachers prepare materials, organize learning activities and adapt educational content to students' needs. However, the wider use of AI also raises concerns about academic honesty, excessive dependence on digital tools and reduced independent thinking among students. The integration of AI is also changing the role of teachers in the educational environment. Today, educators are expected not only to provide knowledge, but also to coordinate digital learning processes and supervise the responsible use of AI technologies. The analysis is based on scientific literature and international data published by OECD, UNESCO and other specialized organizations. International experience shows that successful AI use depends not only on technology itself, but also on institutional regulation, teacher training, ethical standards and effective management practices.*

Keywords: *educational management, artificial intelligence, AI integration, digital transformation, pedagogical risks, academic integrity, educational governance, AI in education.*

JEL: I23, O33, M15, D83.

Introduction

Artificial intelligence is used more actively in modern education and educational management. AI technologies are increasingly used not only during the learning process itself, but also in administrative and management activities within educational institutions. These changes are affecting teaching methods, student assessment and communication between teachers and students. Many researchers note the positive impact of AI on education. Holmes, Bialik, and Fadel argue that artificial intelligence supports personalized learning, adaptive educational models and the automation of routine teaching tasks [3]. Rose Lukin also describes AI as a technology that can strengthen human intelligence in a human-centered educational environment [4]. However, the rapid spread of generative AI has also created new concerns related to academic plagiarism, dependence on automated systems, weaker critical thinking and reduced student autonomy in research activities [6]. The growing use of AI is also changing the professional role of teachers. According to Bates, educators today increasingly work as mentors, coordinators and managers of digital educational environments rather than only as providers of information [1]. Because of this, successful AI implementation depends not only on technical infrastructure, but also on institutional management, teacher training and clear regulations for the use of AI technologies.

International experience shows that many educational institutions are still not fully prepared for large-scale AI integration. UNESCO reports highlight problems connected with ethical regulation, data protection, academic honesty and the absence of clear institutional policies regarding AI use [9], [7]. Therefore, the implementation of AI should be viewed not only as a technological process, but also as an important management task that requires planning, regulation and continuous academic supervision.

AI Integration as a Challenge for Education Management

The use of AI in education creates new responsibilities for teachers, administrators and educational managers, especially in areas related to academic honesty, digital policy and the organization of the learning process. Modern generative AI systems are able not only to process information, but also to create academic content and perform some tasks that were traditionally completed by students and teachers themselves.

Many educational institutions today operate in conditions where technological development is progressing faster than pedagogical methods and internal academic regulations can adapt. Easy access to AI-generated materials creates additional concerns related to academic integrity, independent learning and the development of critical thinking skills. Researchers discuss both the advantages and the risks connected with the growing use of AI in education. Selwyn points to problems related to academic plagiarism, dependence on automated systems and weaker critical thinking among students [6]. At the same time, Holmes, Bialik, and Fadel emphasize that AI technologies can support personalized learning, adaptive education and the optimization of teaching activities [3]. Lukin also considers AI a tool capable of strengthening human intelligence within a human-centered educational environment [4].

The integration of AI is also changing the professional role of teachers. According to Bates, educators are increasingly becoming mentors, coordinators and managers of digital learning environments instead of acting only as traditional sources of information [1]. Because of this, the successful implementation of AI depends not only on technology itself, but also on institutional management, teacher training and clearly defined rules for the use of AI.

UNESCO reports show that many educational institutions still face difficulties related to ethical regulation, data protection and the maintenance of academic honesty in digital learning environments [9], [7]. From a management perspective, effective AI implementation requires not only access to digital technologies, but also internal policies, staff preparation and mechanisms for monitoring the responsible use of AI tools.

Structural Factors Transforming Education with AI

Modern education is changing together with the rapid development of digital technologies and online learning platforms. Because of this, AI tools are becoming more common in schools and universities, both in teaching and in administrative work.

Researchers also connect the spread of AI with the growing demand for flexible and personalized learning. Holmes, Bialik, and Fadel note that AI technologies can support adaptive learning, automated feedback and more individualized educational approaches [3]. Lukin also describes AI as a tool that may strengthen human intelligence in a human-centered educational environment [4].

Many educational organizations are also trying to adapt to labor market changes and improve students' digital competencies. As a result, AI tools are now used not only during classes, but also in organizational and management processes.

However, the active use of AI technologies also creates several concerns. Educational institutions face problems related to academic honesty, dependence on automated systems and weaker critical thinking among students. Selwyn points out that excessive reliance on AI may negatively affect students' independence and analytical skills [6].

UNESCO reports also show that many educational organizations still experience difficulties connected with ethical regulation, data protection and the responsible use of AI technologies in education [7], [9]. Because of this, AI should be viewed not only as a technological innovation, but also as an important educational and management challenge.

International trends in the integration of AI in education

Artificial intelligence is becoming more common in education, so many educational institutions are starting to use AI tools in the learning process. Along with the advantages of these technologies, new problems have also appeared, including lower student independence, increasing academic plagiarism,

insufficient digital skills among teachers and the lack of clear rules for AI use in education. Figure 1 shows how actively teachers use artificial intelligence in different countries.

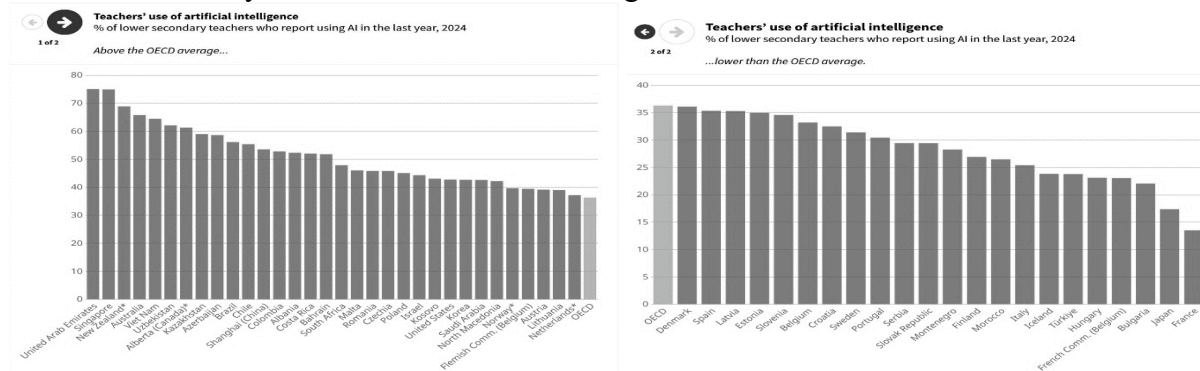


Figure 1 «Teachers' use of article Intelligence»

Source: [5]

According to the chart, the average level of AI use among teachers in OECD countries is around 36%. The highest indicators can be seen in the UAE and Singapore, where approximately 75% of teachers already use artificial intelligence in their professional activities. High levels of AI use are also observed in New Zealand, Australia, Vietnam, Uzbekistan and Kazakhstan. These results suggest that countries with stronger digital education policies usually introduce AI technologies into schools and universities more actively. For example, Singapore pays considerable attention to teacher training and the development of digital competencies. According to OECD data, about 76% of Singaporean teachers have already completed professional training related to the use of AI in education [5]. The use of AI also remains relatively high in the United States and Israel, where educational platforms, digital services and personalized learning technologies are actively developing. In contrast, France and Japan show lower levels of AI use among teachers. This may be connected with a more cautious educational policy and slower adaptation to digital technologies. Overall, international experience shows that the effectiveness of AI implementation largely depends on government support for the digital transformation of education. OECD TALIS 2024 data also indicates that the use of artificial intelligence by teachers continues to increase, especially in countries with highly digitalized educational environments, as presented in Table 1 [5].

Table 1 «Main Areas of AI Use by Teachers»

<i>Applications of AI</i>	Percentage of teachers
<i>Summarizing and analyzing information</i>	68%
<i>Preparing educational materials</i>	64%
<i>Preparing presentations</i>	52%
<i>Creating tests</i>	41%
<i>Analyzing academic performance and grading assignments</i>	25%

Source: Author's creation

The table shows that teachers most often use AI to simplify routine educational tasks and prepare learning materials. According to the OECD TALIS 2024 study, many educators use artificial intelligence for working with information, generating text and creating educational content [5]. AI tools help teachers save time when preparing for classes and make it easier to work with large amounts of information.

Now, the percentage of teachers using AI for grading and analyzing academic performance remains relatively low. This suggests that many educators are still cautious about allowing artificial intelligence to evaluate students' knowledge. Such concerns are mainly connected with possible mistakes, limited transparency of algorithms and questions about the objectivity of AI systems [5].

The spread of AI technologies in education is closely related to the level of digitalization in different countries. International statistics show that AI tools are introduced more actively in educational systems where government policy strongly supports digital technologies and innovation [5].

Despite the advantages of AI technologies, international studies also point to several serious pedagogical risks. One of the most frequently discussed problems is the decline in students' independence, as shown in Table 2 [8].

Table 2 «Major Drawbacks of AI in School Education»

<i>The main drawbacks of AI in education</i>	<i>Percentage</i>
Decreased learner autonomy	72%
Risk of academic plagiarism	68%
Decreased critical thinking	61%
Dependence on technology	57%
Lack of reliability of information provided by AI	55%

Source: Author's creation

According to international studies, many educators believe that the growing use of AI may reduce students' independence. One of the reasons is that generative AI systems allow students to receive ready-made answers and solutions very quickly, often without deeply analyzing the learning material themselves.

In addition, 68% of teachers report an increase in academic plagiarism. Modern AI systems are able to generate high-quality texts, which makes it more difficult for educators to determine whether assignments were completed independently by students [8].

Many teachers also express concern about the decline of students' analytical and critical thinking skills. When students rely too heavily on AI-generated answers, they may become less involved in discussion, analysis and independent problem-solving.

Another important issue connected with the digital transformation of education is the readiness of educational institutions to integrate AI technologies. UNESCO studies show that many educational organizations still do not have fully developed regulations or clear institutional policies for the use of AI in education, as shown in Table 3 [7], [9].

Table 3 «Educational Institutions' Readiness for AI Integration»

<i>Indicator</i>	<i>Value</i>
Higher education institutions that have or are developing AI policies	66%
Institutions without formal AI regulations	more than 30%
Main challenge	lack of uniform guidelines for AI use

Source: Author's creation

The results show that the use of AI in education is becoming not only a technical issue, but also an important organizational and managerial challenge. Educational institutions need to develop clear guidelines for AI use, provide proper training for teachers and monitor compliance with academic honesty standards [10].

Another important priority is the development of digital culture among students. AI technologies should support the educational process and help students work more effectively, rather than fully replace independent learning and critical analysis.

The rapid growth of the global AI in Education market also demonstrates how quickly digital technologies are becoming part of modern education, as shown in Figure 2.

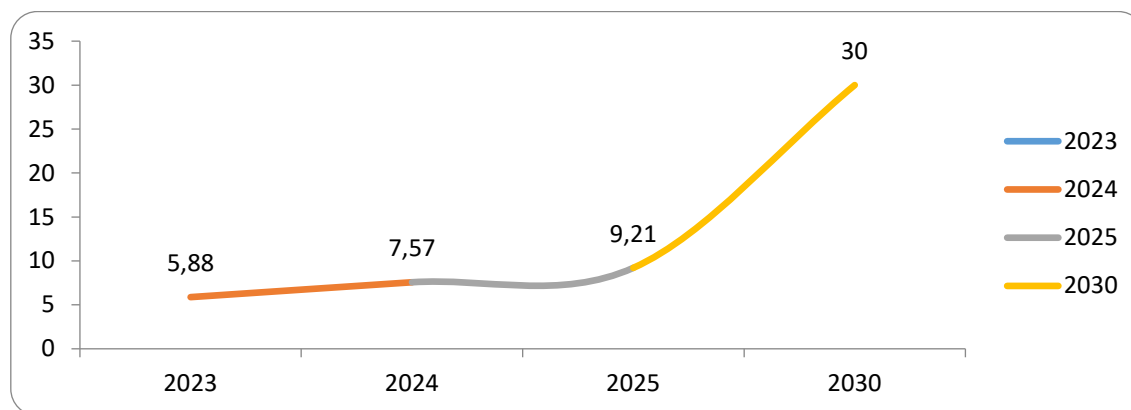


Figure 2 «Growth of the Global AI in Education Market»

Source: Author's creation

Current data shows that the AI market in education is continuing to grow rapidly. According to current forecasts, the global AI in Education market may exceed \$30 billion by 2030, which suggests that AI technologies are likely to remain an important part of modern educational systems for the long term [2].

The analysis also shows that the use of artificial intelligence in education creates both important advantages and serious risks. AI technologies help automate routine teaching tasks, simplify the preparation of educational materials and support more personalized learning approaches. At the same time, excessive dependence on AI may reduce students' independence, contribute to academic plagiarism and increase reliance on digital technologies.

Under these conditions, effective AI implementation requires a clear management approach. Educational institutions need to introduce internal regulations for AI use, improve teachers' digital competencies and create mechanisms for monitoring academic honesty. It is also important to preserve the central role of teachers in the educational process. In practice, AI works most effectively when it supports teachers rather than replaces direct interaction between teachers and students.

The increasing use of AI is also changing the professional role of teachers. Traditional teaching models are gradually becoming more flexible and digitally oriented. The main changes in the teacher's role related to AI integration are presented in Table 4.

Table 4 «Changes in the Teacher's Role with the Integration of AI»

<i>Traditional Model</i>	<i>AI-powered model</i>
Information Source	Mentor and moderator
Manual Assignment Review	Automated analysis
Standard Assignments	Personalized assignments
Knowledge Transfer	Development of analytical skills
Learning Assessment	Coordination of the digital environment

Source: Author's creation

Teaching methods, assessment practices and communication in the educational environment are also gradually changing. In the context of digitalization, greater importance is now placed on coordinating the educational process, developing students' critical thinking skills and managing digital learning environments. Because of this, AI integration requires not only technical training for educators, but also changes in their professional competencies and teaching approaches [7].

Another useful method for analyzing the role of AI in education is SWOT analysis, which makes it possible to examine the strengths and weaknesses of artificial intelligence, as well as the opportunities and potential risks connected with its use in the educational system.

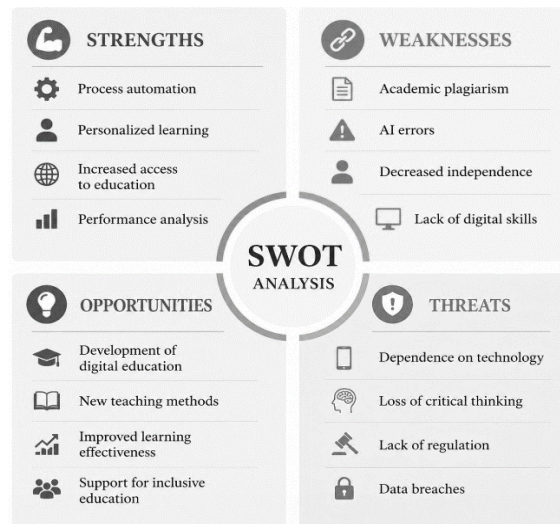


Figure 3 «SWOT Analysis of AI Integration in Education»

Source: Author's creation

The SWOT analysis shows that artificial intelligence has considerable potential for the development of the education system. AI technologies can simplify routine educational tasks, improve access to learning materials and support more flexible learning opportunities for both students and teachers [9]. The use of AI also creates several serious risks, including excessive dependence on technology, reduced student independence and concerns related to the protection of personal data. Because of this, the implementation of AI should be supported by effective management mechanisms, pedagogical supervision, digital literacy and clear institutional regulations. International studies also show that one of the main challenges remains the insufficient preparation of teachers for working with AI technologies. According to OECD TALIS 2024, many educators report a lack of digital competencies and insufficient professional training related to the use of artificial intelligence, as shown in Figure 4 [5].

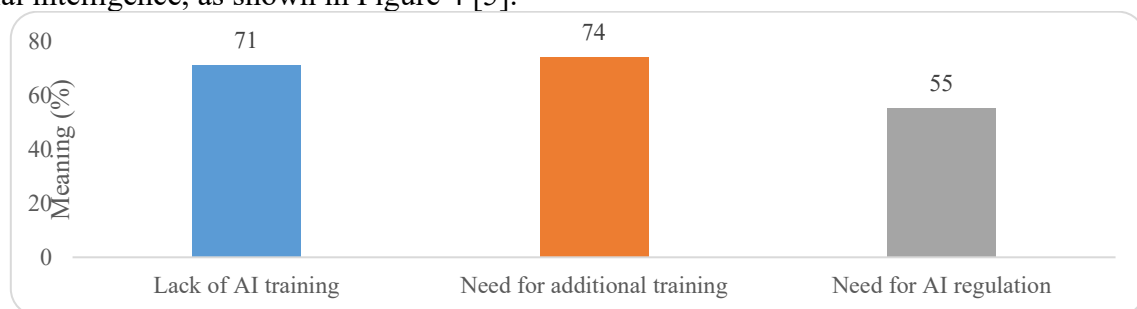


Figure 4 «Training Teachers to Use AI»

Source: Author's creation

We can see from the figure 4 that the successful use of AI in education depends not only on technology, but also on people. Even when educational institutions have the necessary technical infrastructure, the effectiveness of AI largely depends on how well teachers are prepared to work with these technologies [5]. In many universities, teachers still have different attitudes toward AI tools. Some educators actively use AI in their professional activities, while others remain more cautious because of concerns related to academic honesty and the possible decline of students' independent thinking. For this reason, one of the important tasks for the modern education system is the organization of professional development programs that help teachers improve their digital skills and learn how to use AI technologies responsibly.

The collected data also shows that AI technologies help automate routine tasks, simplify the preparation of educational materials and support more personalized learning. However, excessive dependence on AI may reduce students' independence, increase academic plagiarism and strengthen reliance on digital technologies.

Conclusions

Artificial intelligence is already changing the way educational institutions organize teaching, communication and academic management. AI tools influence teaching methods, interaction between teachers and students, and everyday educational processes. They also help reduce routine work and make personalized learning more accessible.

However, the wider use of AI also creates new problems. Educational institutions are facing issues related to academic plagiarism, dependence on automated systems and weaker analytical skills among students. In many cases, the successful use of AI depends not only on technology itself, but also on teacher training, institutional readiness and clear academic rules. The role of teachers is changing as well, since educators are now expected to act not only as sources of information, but also as mentors and coordinators of digital learning environments.

Educational institutions should continue developing ethical standards, improving teacher training and adapting assessment systems to the increasing use of AI technologies. Today, artificial intelligence is becoming not only a technological innovation, but also an important management challenge that requires responsible and balanced use.

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HUMAN RESOURCE MANAGEMENT REQUIREMENTS IN HIGHER EDUCATION INSTITUTIONS IN THE REPUBLIC OF MOLDOVA

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Abstract: *The paper addresses the specific features of human resource management activities within higher education institutions in the Republic of Moldova. The aim of the research is to identify directions for improving human resource management in higher education institutions in the Republic of Moldova in the context of innovative changes. Moreover, the paper examines possibilities for increasing the efficiency of human resource policies within a dynamic environment. The research methodology is complex and includes a wide range of methods, such as analysis, synthesis, induction, deduction, abduction, and content analysis. Therefore, in the context of multiple transformations that have affected the functioning of human resource management within higher education institutions, we consider it appropriate to develop agile and flexible policies that would support the adaptation of higher education institutions to the new context, thereby contributing to increased efficiency and effectiveness of specific human resource management processes.*

Key words: *human resources, higher education institutions, human resource management, human resource policies, human resource strategies.*

JEL: I23, M12.

Introduction

In the context of multiple transformations that have affected the functioning of the business environment, the 21st century imposes demanding obligations on organizations, setting clear limits and outlining strong requirements for both private sector enterprises that seek to remain on the market, grow, and develop, as well as for higher education institutions that aim to enhance their performance levels.

Moreover, in the context of numerous innovative changes—such as the intensive digitalization of institutional processes, the integration of the Sustainable Development Goals (SDGs) into the activities of higher education institutions in the Republic of Moldova, and the adoption of new regulations—the need to improve the human resources of higher education institutions becomes evident, in order to strengthen the skills and competencies required for effective adaptation to new challenges.

Within an unstable external environment, higher education institutions are subject to various transformations, risks, and uncertainties, which are often difficult to implement, manage, and evaluate. This makes the effective management of a public institution increasingly challenging. At the same time, public institutions face the necessity of adapting to various regulations, norms, and innovative principles that must be integrated into their activities, with the aim of enhancing processes and improving resource management capabilities.

Consequently, there is a need to investigate the main transformations in human resource management within higher education institutions that have influenced their functioning in the context of these multiple changes.

Models of human resource management in higher institutions

Compared to other fields of activity where human resources play an important role in ensuring the functionality of organizations, in higher education institutions human resources represent the core of academic innovation, the main driver of change, the cultivation of values, and the development of competencies. Moreover, human resources in the academic environment constitute valuable human capital capable of shaping generations through agility, flexibility, dynamism, and competitiveness. Therefore, ensuring efficient, agile, and high-performing human resource management can contribute to increasing the performance, viability, competitiveness, and sustainability of higher education institutions.

Human resource management involves the continuous improvement of all employees' activities in order to achieve the organization's mission and objectives (Mathis, Nica, Russu, 1997). The implementation of such management requires, as an essential condition, that every manager serves as a model of behavioral attitude. The manager must assume responsibility for the process, actively engage in each action, discuss with employees every issue that arises as well as every progress achieved by the organization's human resources, penalize incorrect actions, and reward positive ones. Managerial actions focus on each employee individually, as a personality and an individual with specific values, aspirations, needs, and behaviors.

Analyzing the approaches of various authors regarding human resource management, we observe that this field is a complex one, including a wide range of activities carried out by organizations in order to ensure the efficient management of human resources.

Thus, according to researcher G. Dressler, "human resource management represents the process of acquiring, training, evaluating, and compensating employees, ensuring their health, safety, and well-being, as well as managing employee relations and equity issues" (Dressler, 2013).

At the same time, researcher Michael Armstrong defines human resource management as "a strategic and coherent approach to managing an organization's most valuable resource—its people—who, individually and collectively, contribute to the achievement of organizational objectives" (Armstrong, 2009).

In the same context, scholar Edwin Filippo states that "human resource management is the planning, organizing, directing, and controlling of human resources to ensure their maximum effective contribution to the achievement of organizational objectives" (Filippo, 2017).

On the other hand, researcher Mathis states that "human resource management involves a series of organizational processes aimed at attracting, developing, motivating, and retaining staff, thus contributing to the success of the organization" (Mathis, Nica, Russu, 1997).

Researcher Alic Bîrcă defines human resource management as "a set of general and specific activities, both having strategic and operational aspect, concerning the attraction, retention, utilization, and efficient motivation of human resources in order to achieve organizational objectives and satisfy employees' personal needs" (Bîrcă, 2014).

At the same time, researcher Adriana Prodan defines human resource management as "an essential component of organizational management, aimed at developing and optimally using human potential in order to achieve the organization's objectives." The researcher emphasizes that human resource management integrates strategic policies and practices focused on recruitment, training, motivation, and employee retention, thereby contributing to overall performance and increasing organizational competitiveness (Nica, Prodan, 2011).

Furthermore, researcher Alina Suslenco approaches human resource management as "a fundamental component of organizational management focused on the development and efficient utilization of human potential within the organization, from a strategic perspective, through planning, recruitment, selection, integration, development, motivation, remuneration, and evaluation of employees, thereby contributing to the increase of organizational performance" (Suslenco, 2025).

Additionally, Ina Crețu and Ala Oberșt define human resource management as “a field aimed at the efficient use of an organization’s personnel through activities such as planning, recruitment, evaluation, and development, with the purpose of achieving organizational objectives” (Crețu, Oberșt, 2020).

In the same context, Emilian Radu states that “human resource management is the process through which organizations manage their human capital, aiming to increase both individual and organizational performance” (Radu, 2008).

On the other hand, Aurel Manolescu defines human resource management as “the totality of strategic and operational decisions and actions through which the recruitment, selection, motivation, and development of an organization’s personnel are ensured” (Manolescu, 2003).

As a result of the analyzed definitions, it can be highlighted that human resource management is a strategic component of an organization which, through its activities, supports the optimal utilization of human resources by means of policies, procedures, and practices aimed at aligning employees’ individual objectives with the organization’s goals.

Human resources represent the creative, active, and coordinating element of organizational activity, having a decisive influence on the effective use of material, financial, and informational resources. Describing people as “resources” emphasizes their importance and highlights the fact that their management requires high levels of genuine concern, attention, and professionalism.

The strategic dimension of human resources within organizations is highlighted in the Harvard School model, developed early in 1984 (Figure 1). The behaviors associated with roles required for each type of competitive strategy differ and can be influenced through a coherent set of human resource management practices.

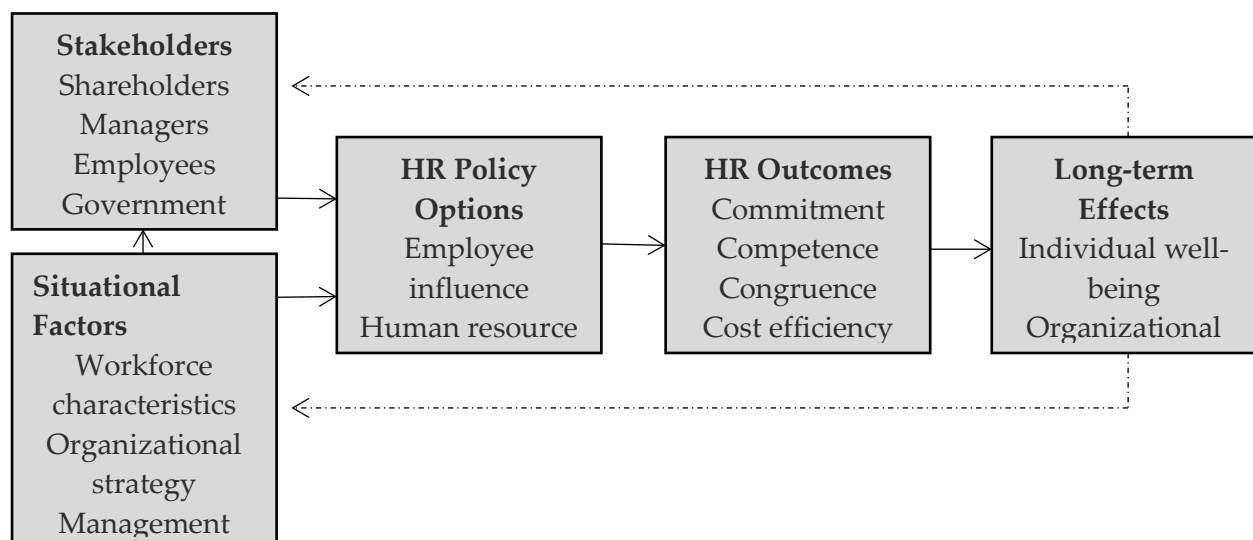


Figure 1. The Harvard School Model of Human Resource Management

Source: Beardwell, I.; Holden, L.; Claydon, T. (2003). Human Resource Management: A Contemporary Approach. 4th ed. Harlow: Prentice Hall, 739 p. ISBN 0273679112.

In this regard, Paauwe and Boon (2009) argue that, in the case of an innovation-oriented strategy, human resource management practices play the role of supporting collaborative and interdependent behavior, with a long-term vision, as well as stimulating the exchange of ideas and risk-taking. Relevant examples in this context include variable compensation systems and flexible career paths. These elements provide a clear perspective on how the content of a specific strategy correlates with the types of human resource policies required for its effective implementation.

The Harvard School Model (1984) represents one of the most influential conceptual frameworks in the field of human resource management, as it places employees at the center of organizational strategy and emphasizes their role as a strategic resource, not merely an operational one.

A first relevant aspect of the model is its holistic approach. It does not treat HRM practices in isolation but integrates them into a coherent system aligned with the organization's strategy, the external environment, and the interests of stakeholders. Thus, the model highlights that decisions regarding human resources are not neutral; rather, they directly influence organizational performance and long-term outcomes.

However, the model is not without limitations. One of the main criticisms concerns its relatively general and theoretical nature, which can make direct practical application within organizations difficult. Additionally, it does not always provide concrete guidance regarding the optimal selection of HRM practices depending on the specific context.

Therefore, the Harvard School Model remains a fundamental reference in the specialized literature, offering a strategic and integrated perspective on human resource management, but it requires adaptation and contextualization to be effectively applied in practice.

With the evolution of society and the development of human resource management practices, another model emerged in 2000—the AMO Model (Ability, Motivation, Opportunity). The AMO Model represents one of the key contemporary conceptual frameworks in the field of human resource management, used to explain the mechanism through which HRM practices influence organizational performance.

Initially formulated in the context of research on high-performance work systems, the model was consolidated in the work of Eileen Appelbaum, Thomas Bailey, Peter Berg, and Arne L. Kalleberg (2000), and was later further developed and refined in the specialized literature by researchers such as John Purcell and Patrick Wright.

The "Ability" dimension reflects the level of employees' competencies, knowledge, and skills, being directly influenced by recruitment, selection, and professional training processes. "Motivation" refers to the intensity and direction of the effort made by employees, shaped through reward systems, performance evaluation, and recognition policies. "Opportunity" concerns the extent to which the organization provides employees with the possibility to utilize their potential through participation, autonomy, communication, and involvement in the decision-making process.

From a functional perspective, the model highlights that human resource management practices do not directly generate performance, but rather act indirectly by influencing these three behavioral conditions. Thus, organizational performance emerges as a result of the interaction between the capacity to work effectively, the willingness to exert effort, and the existence of an organizational framework that enables the manifestation of these resources.

In essence, the AMO model provides an integrative and operationalizable approach to the relationship between human resources and performance, being widely used in the analysis of high-performance work systems and in studies concerning the effectiveness of HRM practices in modern organizations. As a result of the development of the AMO model, the 2000s saw the emergence of the HPWS (High-Performance Work Systems) model, which is based on the idea that universities should manage their academic and administrative staff through an integrated set of HRM practices that directly influence the quality of the educational process. The HPWS model focuses on integrated human resource management activities carried out by higher education institutions in the context of adapting to multiple changes in the external environment, which require increased adaptability and flexibility from universities. Schematically, the functionality of the model is illustrated in Figure 2.

The HPWS model represents a reference framework for conceptualizing the complex human resource management processes within higher education institutions. It highlights interconnected HRM processes carried out in universities through the efficient utilization of human capital and scientific-academic potential, emphasizing active involvement in order to enhance organizational performance.

Based on the characteristics of the core functioning process of universities—which relies on the educational, pedagogical, and scientific interaction of education and research actors—it can be unequivocally stated that human resources constitute the primary resource of the university. At the same time, the main process of universities is characterized by an inherent dependence on the development of human resources. The quality of human resources is determined by two main factors: the quality of individual human resources and the quality of their integration into the university's human resource system (Stangis, 2017).

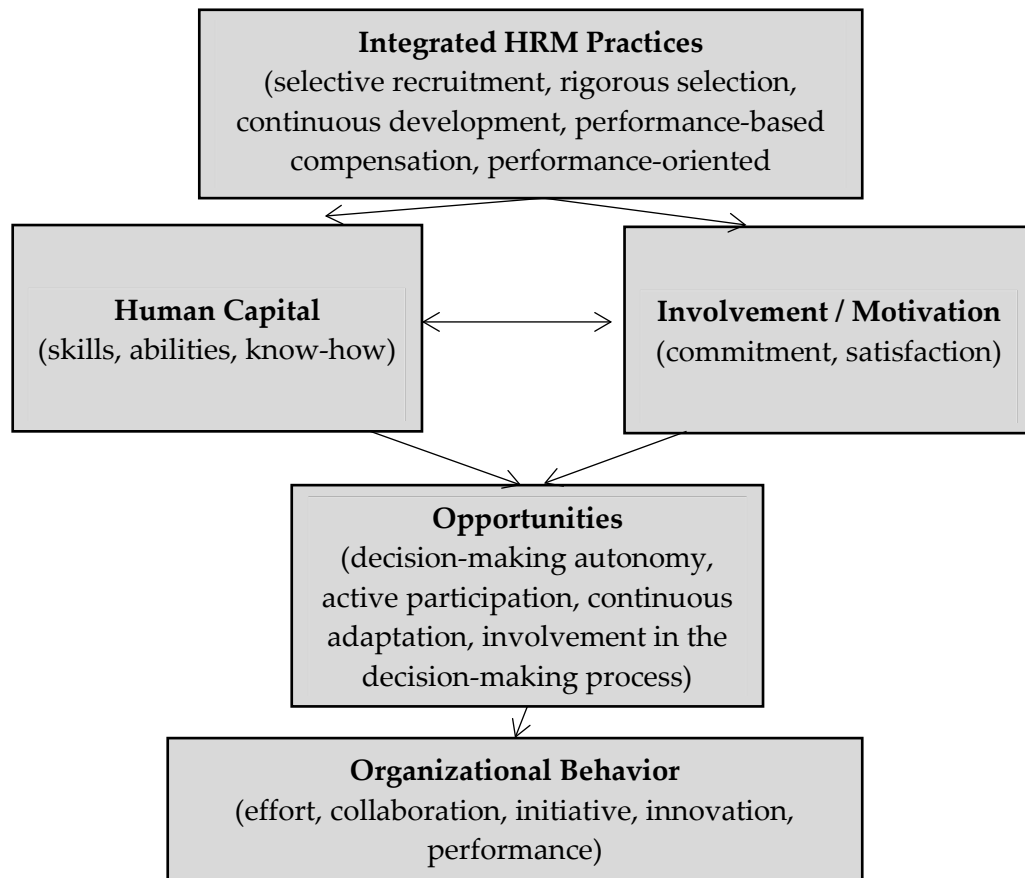


Figure 2. The HPWS Model of Human Resource Management within Higher Education Institutions

Source: APPELBAUM, E.; BAILEY, TH.; BERG, P. et.al. (2000). Do High Performance Work Systems Pay Off. In: Research in the Sociology of Work, nr.10, p.85-107.

Human resource management in higher education institutions in the Republic of Moldova represents a complex system of administrative, strategic, and academic processes aimed at:

- recruiting and developing academic and administrative staff;
- ensuring the quality of the educational and research process;
- aligning human resources with the mission of the university.

According to the specialized literature, university HRM is distinguished by the fact that academic staff (professors, researchers) has a dual role: teaching activity and scientific activity, which are harmoniously integrated in achieving institutional performance.

The main human resource management processes within higher education institutions in the Republic of Moldova involve multiple integrated processes focused on the efficient utilization of human resources in order to increase organizational performance. Moreover, each higher education

institution seeks to continuously develop its scientific and teaching human capital in order to enhance the competitiveness and sustainability of higher education institutions.

The overall set of human resource management processes carried out in universities is presented in Table 1.

Table 1. The set of Human Resource Management (HRM) processes carried out in universities

HRM processes	Process description
Human resource planning	- analysis of the need for teaching staff - aligning the provision of teaching staff with study programs and the number of students - planning of positions
Recruitment and selection	- public competitions for academic positions - existence of predefined criteria: scientific degrees, publications, experience - evaluation by specialized committees
Employment and contracting	- conclusion of the individual employment contract in accordance with the Labour Code of the Republic of Moldova - establishment of the teaching workload - clear definition of duties: teaching activity, scientific activity, etc.
Training and professional development	- teaching improvement - academic mobility - participation in projects and continuous development in research
Academic performance evaluation	- multi-source evaluation of teaching activity: students, supervisors, business environment, etc. - evaluation of scientific activity: preparation of annual reports on research activity
Compensation and motivation	- salary based on budgetary pay scales - provision of incentives for scientific performance - awarding bonuses and research grants
Academic promotion	- holding of scientific and didactic positions - clear criteria: scientific degrees, publications, experience, etc.

Source: elaborated by the author

The HRM system specific to the university environment is entirely dependent on national and institutional regulations in this field, including:

- Education Code of the Republic of Moldova no. 152/2014;
- Labour Code of the Republic of Moldova no. 154/2003;
- Law no. 270/2018 on the salary system in the budgetary sector;
- Integrity Law no. 82/2017;
- Regulations of the Ministry of Education and Research of the Republic of Moldova regarding higher education institutions;
- ANACEC regulations;
- Internal regulations of higher education institutions.

At the same time, it should be emphasized that in recent years, profound changes have taken place regarding HRM within universities in the Republic of Moldova.

The most significant changes that have affected the functioning of HRM processes within higher education institutions in the Republic of Moldova are presented in Figure 3.

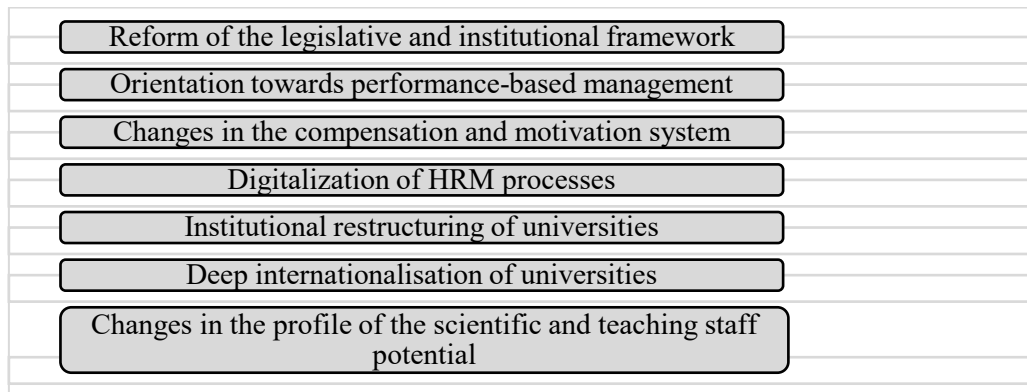


Figure 3. Main changes in HRM processes in universities

Source: elaborated by the author

One of the most extensive changes has been *the reformulation of the legislative framework and financial autonomy*. In recent years, amendments have been introduced to the Education Code of the Republic of Moldova, granting universities greater autonomy, strengthening financial independence, and introducing regulations related to meritocracy and public competitions for academic positions. At the same time, ethical and integrity standards in the recruitment and promotion process have been reinforced, making compliance with ethical norms and professional integrity a mandatory requirement for teaching staff.

Orientation towards performance-based management: in recent years, universities in the Republic of Moldova have increasingly integrated performance-oriented management systems, strengthening KPIs through the evaluation of publications, scientific research activity, and teaching performance. In addition, university HRM increasingly incorporates international criteria for academic promotion, based on teaching staff performance.

Changes in the compensation and motivation system: in recent years, the Ministry of Education and Research of the Republic of Moldova has sought to increase the attractiveness of the teaching profession by providing multiple benefits such as increased allowances for scientific degrees (PhD and habilitated doctor), salary increases, and the introduction of clear systems for evaluating and stimulating academic performance.

Digitalization of HRM processes: in recent years, the digital transformation of universities has become increasingly evident, significantly affecting the functioning of HRM departments as well. This includes electronic records of scientific and teaching staff, the implementation of information systems for HRM processes in universities, and the digitalization of administrative processes. These developments have increased the adaptability and agility of HRM processes within higher education institutions.

Institutional restructuring of universities is another important change related to the reorganization of higher education institutions in order to strengthen their capacities. This process has involved mergers and absorptions that began in 2022 and continue to the present day. Thus, some universities such as the State Agrarian University of Moldova and the Academy of Public Administration, as well as research institutes, have been absorbed or merged into universities such as MSU, TUM, and ASEM. This has increased their scientific and teaching potential, as well as their competitiveness.

Deep internationalization of universities: in recent years, due to globalization, universities have expanded their internationalization efforts, even developing their own internationalization strategies through which they aim to strengthen collaboration with European universities, as well as focus on accessing international projects, international research, and publishing in indexed international journals.

Changes in the profile of scientific and teaching staff potential: along with these developments, profound changes can be observed in the profile of university academic staff, such as increased recruitment requirements (PhD becoming mandatory for most positions); greater emphasis on staff involvement in international projects and collaborations; and growing interest in young academic staff with high development potential.

Following these changes in the functioning of HRM processes within higher education institutions, the main associated challenges are highlighted in Figure 4.

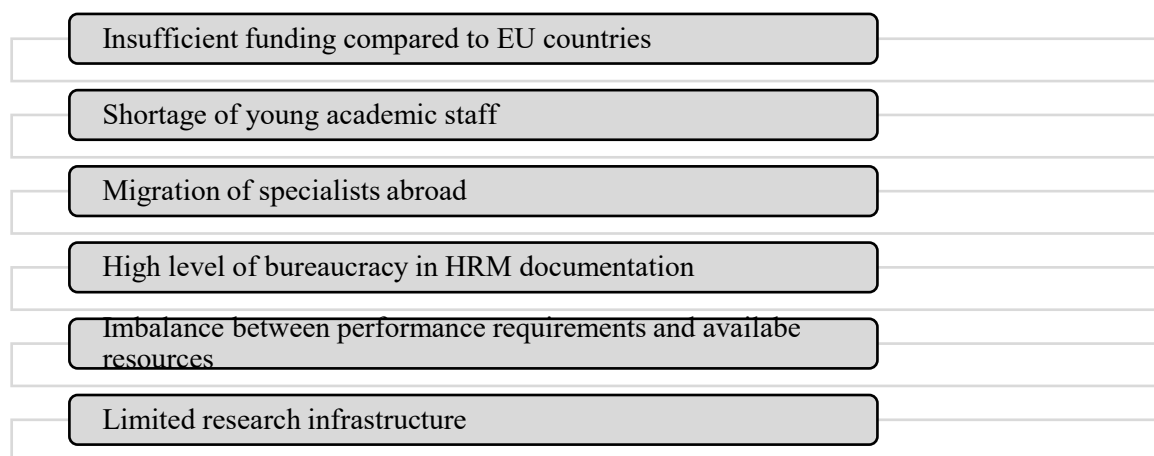


Figure 4. Challenges in HRM processes in universities

Source: elaborated by the author

Insufficient funding compared to EU countries – the higher education system in the Republic of Moldova is largely dependent on public funding, which is often limited. In some cases, financial constraints affect universities' involvement in research projects, as co-financing from higher education institutions is required. Insufficient funding leads to lower salaries for academic staff and researchers, reducing the attraction of young teaching staff. Overall, insufficient funding has a systemic impact on the functioning of all HRM processes carried out by universities.

Shortage of young academic staff – the Republic of Moldova faces a shortage of young teaching staff. Only about 25–30% of graduates from pedagogical specializations enter the labor market. Although in recent years the Ministry of Education and Research of the Republic of Moldova has implemented a number of measures aimed at increasing the attractiveness of pedagogical careers, this issue continues to remain a significant challenge.

Migration of specialists abroad – the brain drain phenomenon continues to affect the academic environment in the Republic of Moldova, reducing opportunities for development and decreasing the competitiveness of the university sector.

High level of bureaucracy in HRM documentation – HRM processes specific to universities are often excessively bureaucratic, imposing a formal and rigid framework of activity determined by numerous regulations and norms that ensure strict control of processes. At the same time, the lack of digitalization of HRM processes reduces opportunities for rapid adaptation to change.

Imbalance between performance requirements and available resources – although the requirements imposed on universities in the country are very high in terms of visibility, academic performance, and compliance with international standards, the limited human and financial resources reduce the development opportunities of higher education institutions.

Limited research infrastructure – although in recent years investments of over 40 million euro have been made in equipping educational spaces within higher education institutions by the Ministry of Education and Research of the Republic of Moldova, most laboratories still require technical modernization, as well as increased allocation of resources for research development.

Conclusions.

In conclusion, it can be noted that although in recent years multiple changes have been implemented in order to improve the development processes of higher education institutions in the Republic of Moldova, universities in the country still face numerous challenges in the field of human resource management. These challenges hinder the development of higher education institutions on the one hand, and reduce opportunities for increasing the competitiveness and sustainability of the national higher education system on the other.

As a result, there is a need to accelerate the transition of the university development system from an administrative one to a strategic and competitive model, which would enhance the image and visibility of higher education institutions at the international level, as well as contribute to increasing their competitiveness. However, these objectives can only be achieved through increased funding allocated to universities, the implementation of active policies for the integration of young professionals into academia, the reduction of bureaucracy through the digitalization of processes, and increased investment in research.

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AGRICULTURAL RISK INSURANCE AS A TOOL FOR IMPROVING THE ECONOMIC EFFICIENCY OF CROP PRODUCTION IN THE CONTEXT OF CLIMATE CHANGE IN MOLDOVA

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Abstract: *Climate change and the increasing frequency of extreme weather events represent major challenges for agricultural production in the Republic of Moldova. Crop production is particularly vulnerable to climatic hazards such as droughts, hailstorms, and frosts, which generate significant fluctuations in agricultural output and farmers' incomes. In this context, agricultural risk insurance plays an important role as a financial instrument for mitigating production risks and improving the economic efficiency of agricultural activities. The aim of this study is to analyse the role of subsidized agricultural risk insurance in strengthening the resilience of crop production in Moldova. The research is based on statistical data provided by the National Bureau of Statistics and the Agency for Interventions and Payments in Agriculture, covering the period 2013–2024. The results indicate a significant expansion of the subsidized agricultural insurance program after 2021, reflected in the increase in the number of insurance applications and the volume of subsidies allocated. The analysis also shows that hail, drought, and frost represent the most frequently insured risks, while the territorial distribution of subsidies reveals a strong concentration in several districts with intensive crop production. The findings highlight the importance of agricultural insurance as a policy instrument for reducing climate-related risks and enhancing the economic efficiency and resilience of the agricultural sector.*

Key words: agricultural insurance; climate change; crop production; risk management; agricultural subsidies.

JEL: Q18, G22.

Introduction

Climate change represents one of the most significant challenges affecting global agricultural production. Rising temperatures, changes in precipitation patterns, and the increasing frequency of extreme weather events such as droughts, floods, and heat waves are already affecting crop productivity and agricultural stability (Alotaibi, 2023; Yuan et al., 2024). Because agricultural production depends heavily on climatic conditions, these changes can disrupt crop growth cycles, increase pest and disease pressures, and reduce agricultural yields (Yuan et al., 2024).

Extreme weather events have significantly increased production risks in agriculture and have generated substantial economic losses worldwide. Droughts, excessive rainfall, and temperature fluctuations can negatively affect crop yields and farm incomes, thereby increasing the vulnerability of agricultural systems (Zeng et al., 2025). In this context, effective risk management strategies are essential to reduce production uncertainty and support the sustainability of agricultural activities.

Agricultural insurance is widely recognized as an important financial instrument for managing production risks and stabilizing farmers' incomes. By transferring part of the production risk to insurance providers, farmers can mitigate the financial consequences of adverse climatic events and maintain production activities despite unfavorable environmental conditions (Kramer et al., 2022). Moreover, agricultural insurance may encourage farmers to adopt innovative technologies and efficiency-enhancing production practices, contributing to improved farm economic performance.

In the Republic of Moldova, agriculture plays a crucial role in the national economy but remains highly vulnerable to climate-related risks. The sector is strongly affected by droughts, frosts, and

other extreme weather events that cause significant fluctuations in agricultural output and farmers' incomes (Cimpoieș & Grubleac, 2023). Severe droughts have led to substantial reductions in agricultural production, highlighting the vulnerability of crop production to climate variability. Under these conditions, agricultural risk insurance represents an important policy instrument for improving the resilience and economic efficiency of crop production.

Basic content

Agricultural production is strongly influenced by climatic conditions, which makes the sector highly vulnerable to various natural risks. In Moldova, agriculture remains an important component of the national economy despite the gradual decline of its contribution to GDP. The sector remains a key pillar of the economy, making a strong contribution to exports and employing roughly one-third of the workforce. However, agricultural output has been highly volatile in recent decades, largely as a result of increasing climate variability.

Table 1. Agricultural production dynamics and major climate shocks in the Republic of Moldova

Year	Gross agricultural production (million MDL)	Plant production (million MDL)	Share of plant production (%)	Climate event
2007	12,825	7,941	61.9	Severe drought
2009	13,300	7,861	59.1	Drought affecting crop yields
2012	19,922	11,968	60.1	Extreme drought
2015	27,193	18,082	66.5	Recovery after climatic shocks
2020	30,061	20,389	67.8	Severe drought
2021	48,434	37,838	78.1	Strong recovery year
2022	40,617	27,208	67.0	Climate instability
2024	41,632	28,014	67.3	Production stabilization

Source: own design based on the data from National Bureau of Statistics

Analyzing agricultural production dynamics and major climate shocks (Table 1), we can mention that agricultural production in the Republic of Moldova generally increased between 2000 and 2024, even though this growth was marked by considerable variability, largely driven by climate conditions. By 2024, gross agricultural output was about 33.4 billion MDL higher than in 2000, indicating a clear expansion of the sector over the period analyzed. Nevertheless, there were several years when production dropped significantly, mainly due to extreme weather events such as droughts.

Plant production represents the dominant component of the agricultural sector, accounting on average for around 70% of total agricultural output. Consequently, fluctuations in crop yields have a major impact on the overall performance of agriculture. The data show that years characterized by severe droughts, such as 2007, 2009, 2012, and 2020, were associated with significant reductions in agricultural production, highlighting the strong dependence of the sector on climatic conditions.

The most favorable year during the analyzed period was 2021, when gross agricultural production reached 48,434 million MDL, representing the highest level recorded in national statistics. This exceptional performance was largely driven by favorable climatic conditions and improved crop yields. Nevertheless, the considerable volatility observed in agricultural production over time demonstrates the high vulnerability of the sector to climatic risks.

Under such circumstances, the implementation of effective risk management mechanisms becomes essential for stabilizing farm incomes and reducing production uncertainty. One of the most important instruments for supporting farmers' agricultural income and protecting crop yields is agricultural crop insurance. Crop insurance programs aim to mitigate production risks by providing financial compensation when farmers experience losses caused by adverse events, thereby reducing the negative economic consequences of unfavorable climatic conditions (Ramsey & Santeramo, 2017).

In many countries, governments play a significant role in the development of agricultural insurance systems by defining the conditions of insurance contracts, establishing premium levels, subsidizing insurance costs, and acting as reinsurers for insurance companies providing such services. These programs are designed to protect farmers against a wide range of risks, including drought, pest infestations, lightning, strong winds, and excessive moisture.

For example, in 2023 the European Commission approved a €1.3 billion state aid scheme in Poland aimed at subsidizing agricultural insurance premiums for certain crop and livestock products. The objective of this measure is to ensure income stability for farmers and address market failures that could discourage producers from purchasing insurance due to high premium costs. Furthermore, public reinsurance mechanisms are often required for catastrophic risks such as drought, since private insurance companies are frequently reluctant to provide coverage for such high-risk events.

In the Republic of Moldova, where agriculture is highly exposed to climatic uncertainties, the development of agricultural risk insurance has become a key policy instrument for strengthening the resilience and efficiency of crop production.

The country's agricultural insurance system started to develop with the adoption of Law No. 243/2004 on subsidizing agricultural risk insurance. Under this framework, farmers who insure their crops against production risks through licensed insurance companies can benefit from state support covering roughly 50% to 60% of the insurance premium. This policy has been in effect since 2005, following the Government's approval of the regulation on subsidizing agricultural production risk insurance, and has since served as an important mechanism to support farmers in managing weather-related risks.

The regulation aims to compensate farmers for part of the costs associated with insuring agricultural crops and livestock against various production risks. Under this mechanism, farmers can benefit from subsidies if they conclude an insurance contract in accordance with the established regulations and pay the remaining portion of the insurance premium, which represents the difference between the total premium and the subsidized amount provided by the state. The level of subsidization is determined according to the list of eligible risks and the list of agricultural crops, livestock species, and poultry covered under the program. Financial resources for these subsidies are allocated from the National Fund for the Development of Agriculture and Rural Environment.

In addition to insurance subsidies, the government may also provide additional financial support to farmers in order to mitigate the negative consequences of adverse weather events. For example, following the severe drought that affected the agricultural sector in 2012, the Government adopted Regulation No. 766, which provided financial assistance to help farmers overcome the economic losses caused by that climatic shock.

Overall, the introduction of subsidized agricultural insurance in Moldova represents an important step toward strengthening the risk management framework in agriculture. By facilitating farmers' access to insurance and covering part of the premium costs, the government seeks to limit production-related risks, ensure more stable farm incomes, and strengthen the sector's capacity to cope with growing climate variability.

To assess how this support mechanism has functioned in practice, it is important to examine trends in farmers' participation in the subsidized agricultural insurance program, as well as the level of public funding allocated to it. Indicators such as the number of subsidy applications submitted, approval rates, and the total value of subsidies granted between 2013 and 2024 offer valuable insights into the program's evolution. For a clearer analysis, the period is divided into two main stages: the initial implementation phase (2013–2020) and the subsequent expansion phase (2021–2024).

Table 2. Dynamics of subsidized agricultural risk insurance in Moldova by program development phases (2013–2024)

Year	Applications submitted	Approval rate (%)	Subsidy allocated (thousand MDL)	Avg. subsidy per approved application (thousand MDL)
Phase I – Initial development of the program (2013–2020)				
2013	81	96.3	41,288.2	529.3
2014	122	54.0	22,760.5	344.9
2015	137	93.4	30,858.0	241.1
2016	118	73.7	8,875.8	102.0
2017	83	96.3	4,474.9	55.9
2018	122	97.5	7,409.5	62.2
2019	84	94.0	5,438.7	68.8
2020	82	98.8	7,522.4	92.9
Phase II – Expansion of the insurance support scheme (2021–2024)				
2021	463	90.7	41,673.9	99.2
2022	527	99.4	63,914.2	121.9
2023	162	95.1	50,603.7	328.6
2024	684	99.2	89,100.6	131.2

Source: Author's calculations based on data from the Agency of Interventions and Payments in Agriculture (AIPA).

The data presented in Table 2 reveal the evolution of the subsidized agricultural risk insurance program in the Republic of Moldova and highlight two distinct stages in its development. During the initial implementation phase (2013–2020), the number of subsidy applications remained relatively modest, generally fluctuating between 80 and 140 applications annually. Despite this limited participation, the approval rate was consistently high in most years, exceeding 90%, which reflects the institutional willingness to support farmers through this risk management instrument. An exception was recorded in 2014, when the approval rate dropped to 54%, suggesting possible administrative or financial constraints in the implementation of the program during that year. Financial allocations during the first phase also show considerable fluctuations. In 2013, the amount of subsidies allocated reached 41.3 million MDL, representing the highest level during the early years of the program. However, in the following years the allocated subsidies decreased significantly, reaching a minimum of 4.5 million MDL in 2017, which indicates a relatively limited scale of the insurance support mechanism during this period. The average subsidy per approved application also declined considerably, from 529.3 thousand MDL in 2013 to around 55–92 thousand MDL in the period 2017–2020, suggesting a reduction in the financial intensity of support per beneficiary. A significant structural change can be observed beginning with 2021, marking the expansion phase of the agricultural insurance support scheme. In that year, the number of subsidy applications increased sharply to 463, representing an increase of more than five times compared with 2020. This rapid growth reflects the strengthening of government support for agricultural risk insurance, particularly through increased subsidy rates covering a larger share of the insurance premium. The upward trend continued in 2022, when the number of applications reached 527, while the total subsidy allocated increased to 63.9 million MDL, demonstrating a substantial expansion of the program. The high approval rate of 99.4% in that year further confirms the strong institutional support provided to farmers participating in the insurance scheme. Although 2023 recorded a temporary decrease in the number of applications to 162, the financial support allocated remained relatively high at 50.6 million MDL, resulting in a significant increase in the average subsidy per approved application, which reached 328.6 thousand MDL. This suggests

that although fewer applications were submitted, the insured values or the scale of coverage per application may have increased.

The most notable development occurred in 2024, when the number of submitted applications reached 684, the highest level recorded during the analyzed period. At the same time, the total subsidy allocated increased to 89.1 million MDL, reflecting the continued expansion and consolidation of the subsidized agricultural insurance program. The approval rate of 99.2% also indicates the high accessibility of this support mechanism for farmers.

Overall, the evolution of the program demonstrates the growing importance of agricultural risk insurance as a key policy instrument for managing climatic and production risks in the agricultural sector. The significant increase in both the number of applications and the financial resources allocated after 2021 suggests a rising awareness among farmers regarding the importance of insurance mechanisms, particularly in the context of increasing climate variability and production uncertainty. The analysis of insured agricultural risks provides valuable insights into farmers' risk perception and the main climatic threats faced by the agricultural sector. In this context, the structure of insured risks, the corresponding insured areas, and the financial contributions of both farmers and the state subsidies offer a clearer picture of the role played by agricultural insurance in protecting crop production against adverse weather events during the period 2021–2024.

Table 3. Structure of insured agricultural risks in Moldova (2021–2024)

Type of risk	Total insured area (ha)	Farmer contribution (thousand MDL)	Subsidy allocated (thousand MDL)
Storms	108.2	77.6	0
Hail	19,556.3	18,466.2	39,641.7
Hail + spring frost	4,727.1	20,138.4	24,668.0
Hail + spring frost + torrential rain	730.4	7,554.0	7,268.9
Hail + torrential rain + excessive drought	11,582.2	15,300.0	16,593.5
Hail + excessive drought	7,814.4	9,747.9	12,687.1
Fires	842.0	9.6	28.7
Spring frost	677.2	3,055.5	4,222.1
Drought + hail	7,732.7	4,657.6	10,867.5
Early autumn/winter and late spring frost + hail	1,939.6	7,869.0	11,060.8
Early autumn/winter and late spring frost	5,114.9	9,218.4	15,555.9

Source: Author's calculations based on data from the Agency of Interventions and Payments in Agriculture (AIPA).

The analysis of the structure of insured agricultural risks during the period 2021–2024 shows that insurance coverage in the Republic of Moldova is concentrated mainly on hail-related risks, either individually or in combination with other climatic hazards. Hail as a single risk covers the largest insured agricultural area, amounting to 19,556.3 ha, which represents the highest value among all risk categories included in the program. At the same time, this risk category received the largest amount of subsidies, totaling 39,641.7 thousand MDL, indicating the significant financial impact that hail events can have on agricultural production.

Combined risk categories also play an important role in the agricultural insurance structure. For example, insurance contracts covering hail together with torrential rain and excessive drought account for 11,582.2 ha of insured agricultural land, with subsidies amounting to 16,593.5 thousand MDL. Similarly, risks combining hail and excessive drought cover 7,814.4 ha, while the corresponding subsidy allocations reach 12,687.1 thousand MDL. These figures highlight the growing importance of insurance products covering multiple climatic hazards, reflecting the increasing complexity of weather-related risks affecting crop production.

Another relevant category includes risks associated with frost phenomena, such as spring frost or combined early autumn, winter, and late spring frost events. Insurance contracts covering these risks represent 5,114.9 ha of insured area, with subsidies amounting to 15,555.9 thousand MDL, which indicates the significant potential damage that frost events can cause to sensitive crops, particularly fruit trees and early-season crops.

In contrast, certain risks such as storms and fires account for relatively small insured areas and lower financial allocations. For example, storm-related risks cover only 108.2 ha, while fires account for 842 ha of insured agricultural land, indicating that these risks are less frequently insured compared with hail, drought, and frost-related hazards.

Overall, the distribution of insured risks demonstrates that climatic hazards related to extreme weather events dominate the agricultural insurance market in Moldova. The predominance of hail, drought, and frost-related risks reflects the vulnerability of crop production to climate variability and extreme weather events. At the same time, the significant level of subsidies allocated for these risks highlights the important role of public financial support in encouraging farmers to adopt agricultural insurance as a key instrument for managing production risks and improving the resilience of agricultural systems.

The predominance of climatic risks such as hail, drought, and frost in the agricultural insurance portfolio also influences the structure of the insurance market and the distribution of public financial support among insurance providers. In order to better understand how the subsidized agricultural insurance mechanism operates in practice, it is important to examine the allocation of subsidies to the insurance companies that provide these services to agricultural producers.

Examining how subsidies are distributed among insurance companies helps to better understand the structure and concentration of the agricultural insurance market, as well as the role of private insurers in delivering the subsidized risk insurance scheme. In this regard, the pattern of subsidy allocations to insurance companies over the period 2013–2024 highlights both the growth of the agricultural insurance program and the increasing participation of insurers in managing production risks in the agricultural sector.

Table 4. Subsidies allocated to insurance companies for agricultural risk insurance by program development phases

Insurance company	2013–2020 (thousand MDL)	2021–2024 (thousand MDL)	Total (thousand MDL)
SA Intact Asigurări Generale	12,339.3	129,797.9	142,137.2
CA General Asigurări SA	7,491.9	91,778.4	99,270.3
CA Moldasig SA	18,695.2	10,233.5	28,928.7
CA Asterra Grup SA	15,965.8	14,697.2	30,663.0
Other insurance companies	64,363.9	1,134.1	65,498.0
Total	118,856.1	247,641.1	366,497.2

Source: Author's calculations based on data from the Agency of Interventions and Payments in Agriculture (AIPA).

The analysis of the distribution of subsidies allocated to insurance companies for agricultural risk insurance reveals significant changes in the structure and scale of the insurance market in the Republic of Moldova (Table 4). It is obvious that the total amount of subsidies allocated through the program increased substantially between the two analyzed periods. During the initial implementation phase (2013–2020), the total subsidies amounted to 118,856.1 thousand MDL, whereas in the expansion phase (2021–2024) the allocated amount more than doubled, reaching 247,641.1 thousand MDL. This increase reflects the expansion of the subsidized agricultural insurance program and the growing importance of insurance mechanisms as a tool for managing production risks in agriculture.

A significant concentration of subsidies among a limited number of insurance companies can also be observed. In the second phase of the program, SA Intact Asigurări Generale became the dominant

insurance provider in the agricultural insurance market, receiving 129,797.9 thousand MDL, which represents the largest share of the total subsidies allocated during this period. Similarly, CA General Asigurări SA also strengthened its position in the market, receiving 91,778.4 thousand MDL in subsidies during 2021–2024. Together, these two companies account for the majority of subsidies allocated in the expansion phase of the program.

In contrast, other insurance companies played a more significant role during the earlier stage of the program. During the period 2013–2020, the category of other insurance companies received the largest share of subsidies, totaling 64,363.9 thousand MDL, indicating a more fragmented market structure during the initial years of the agricultural insurance scheme. However, their participation declined considerably in the second phase, receiving only 1,134.1 thousand MDL during 2021–2024. Companies such as CA Moldasig SA and CA Asterra Grup SA maintained a more stable but comparatively smaller presence in the agricultural insurance market throughout the analyzed period. While Moldasig received 18,695.2 thousand MDL during the first phase, its share declined in the second phase to 10,233.5 thousand MDL, suggesting a relative reduction in its role within the expanding insurance program. Asterra Grup SA maintained relatively balanced allocations across both phases, receiving 15,965.8 thousand MDL in the first period and 14,697.2 thousand MDL in the second.

The allocation of subsidies among insurance companies reveals a clear trend toward market concentration, with a relatively small group of insurers capturing most of the subsidized contracts in recent years. This development reflects not only the expansion of the agricultural insurance scheme but also the emergence of specialized insurers with greater capacity and expertise in managing agricultural risks. At the same time, the marked increase in subsidy volumes after 2021 highlights the pivotal role of public financial support in accelerating the uptake of insurance, reinforcing its function as a key instrument for mitigating climate-related risks and improving the resilience of the agricultural sector. Differences in agricultural specialization, farm structure, and exposure to climatic risks may influence the level of participation in the insurance program at the local level. Therefore, analysing the distribution of subsidies by district allows for a better understanding of the geographical concentration of insured agricultural activities and the regions where agricultural insurance plays a more significant role in mitigating production risks.

Table 5. Districts receiving the largest agricultural insurance subsidies in Moldova (2021–2024)

District	Subsidy allocated (thousand MDL)	Share of total (%)
Briceni	67,117.0	37.3
Telenești	27,438.8	15.2
Ocnita	17,565.3	9.8
Edineț	17,532.4	9.7
Cahul	15,716.8	8.7
Ungheni	7,542.0	4.2
Other districts	27,050.5	15.1
Total	179,962.8	100.0

Source: Author's calculations based on data from the Agency of Interventions and Payments in Agriculture (AIPA).

The territorial distribution of agricultural insurance subsidies during the period 2021–2024 reveals a strong spatial concentration of financial support in a limited number of districts. As shown in Table 5, the district of Briceni received the largest share of subsidies allocated for agricultural risk insurance, amounting to 67,117.0 thousand MDL, which represents 37.3% of the total subsidies distributed during the analyzed period. This dominant share indicates a particularly high level of participation in the agricultural insurance program and suggests a significant exposure of agricultural production in this district to climatic risks.

Other districts also play an important role in the territorial distribution of agricultural insurance subsidies. Telenești ranks second, receiving 27,438.8 thousand MDL, corresponding to 15.2% of the

total subsidies, followed by Ocnița and Edineț, which account for 9.8% and 9.7%, respectively. The district of Cahul also records a significant share of 8.7%, while Ungheni accounts for 4.2% of the total subsidies allocated.

Overall, the five leading districts—Briceni, Telenesti, Ocnița, Edineț, and Cahul—together account for more than 80% of the total agricultural insurance subsidies, indicating a high geographical concentration of insured agricultural activities. These districts are characterized by intensive crop production and a relatively high exposure to climatic hazards such as hail, drought, and frost, which increases the demand for insurance coverage.

In contrast, the remaining districts collectively account for 15.1% of the total subsidies, suggesting a lower level of participation in the agricultural insurance program. This disparity may be explained by several factors, including differences in farm size, crop specialization, farmers' awareness of risk management instruments, and the perceived exposure to climatic risks.

Overall, the territorial distribution of agricultural insurance subsidies highlights significant regional disparities in the adoption of insurance mechanisms. The concentration of subsidies in a limited number of districts suggests that agricultural insurance is more actively used in areas where climatic risks are more pronounced and where agricultural production plays a dominant economic role. These findings underline the importance of targeted policy measures aimed at expanding the adoption of agricultural insurance in less represented regions in order to strengthen the resilience of the agricultural sector at the national level.

Conclusions

Climate change and the increasing frequency of extreme weather events represent major challenges for agricultural production in the Republic of Moldova. The analysis conducted in this study confirms that agricultural output, particularly crop production, is highly sensitive to climatic variability, with droughts and other adverse weather phenomena causing significant fluctuations in production levels. Although the overall trend of agricultural production shows long-term growth, the sector remains vulnerable to climate-related shocks that directly affect farmers' incomes and the stability of agricultural systems.

Under these conditions, agricultural risk insurance represents an important financial instrument for reducing production uncertainty and improving the economic efficiency of crop production. The empirical analysis demonstrates that the subsidized agricultural insurance program implemented in Moldova has evolved significantly over time. During the initial phase of the program (2013–2020), participation remained relatively limited, with a modest number of applications and fluctuating levels of financial support. However, starting from 2021 the program experienced a rapid expansion, reflected in the substantial increase in both the number of insurance applications and the volume of subsidies allocated through the National Fund for the Development of Agriculture and Rural Environment.

The analysis of insured risk categories indicates that climatic hazards dominate the agricultural insurance portfolio. Hail-related risks, either individually or in combination with other phenomena such as drought, torrential rainfall, and frost, represent the largest share of insured areas and subsidy allocations. This pattern reflects the significant exposure of crop production to extreme weather events and highlights the importance of insurance mechanisms for mitigating the financial consequences of climate-related losses.

The study also reveals a growing concentration of the agricultural insurance market. In recent years, a limited number of insurance companies have accounted for the majority of subsidized insurance contracts, reflecting both the expansion of the program and the increasing specialization of certain insurers in agricultural risk coverage. At the same time, the territorial analysis shows that agricultural insurance subsidies are unevenly distributed across the country, with a strong concentration in several districts such as Briceni, Telenesti, Ocnița, Edineț, and Cahul. These districts are characterized by intensive crop production and higher exposure to climatic risks, which increases the demand for insurance coverage.

Overall, the results of the study demonstrate that subsidized agricultural insurance plays a crucial role in strengthening the resilience of the agricultural sector in the context of climate change. By partially compensating farmers for insurance premiums and facilitating access to insurance services, public support mechanisms contribute to stabilizing farm incomes, reducing production risks, and encouraging the adoption of risk management strategies. Thus, expanding agricultural insurance programs, alongside greater farmer awareness and well-targeted regional policies, could significantly improve the effectiveness of this tool and contribute to the long-term sustainability and economic performance of crop production in Moldova.

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ESG UNDER PRESSURE: CHALLENGES AND MATERIALITY STRATEGIES IN FINTECH

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Abstract: *This study investigates the challenges FinTech companies face when implementing Environmental, Social, and Governance (ESG) frameworks under conditions of regulatory uncertainty, and the materiality-driven strategies they deploy to overcome them. The proliferation of ESG requirements across global jurisdictions has created a fragmented and fast-evolving compliance landscape, placing disproportionate pressure on FinTech firms whose rapid growth and leaner organizational structures limit compliance capacity. Despite growing ESG scholarship in finance, empirical research addressing FinTech-specific implementation challenges under regulatory uncertainty remains limited.*

Methodologically, the study adopts an interpretivist, inductive approach grounded in qualitative inquiry. Semi-structured interviews were conducted with senior ESG professionals across consulting, private equity, and corporate roles, selected through stratified purposive sampling to capture both internal implementers and external advisors. Data were analysed through iterative grounded theory coding, open, axial, and selective, allowing theory to emerge directly from participant experience.

Findings reveal that regulatory uncertainty is the dominant barrier to ESG implementation, manifesting as shifting compliance requirements, resource misalignment, unclear board direction, and superficial tick-box behaviours. In response, high-performing FinTech firms adopt materiality-driven prioritization, concentrating ESG investment on issues of greatest financial and stakeholder relevance. Firms applying these strategies demonstrate stronger ESG integration and generate measurable business value beyond compliance, including improved capital access, talent retention, and competitive differentiation.

These findings contribute to both theoretical and practical discourse on sustainable finance in FinTech, offering actionable guidance for practitioners navigating regulatory complexity and for policymakers seeking to reduce the cost of regulatory fragmentation on fast-growing firms.

Keywords: *ESG implementation; regulatory uncertainty; materiality; FinTech*

JEL: G28; G32; M14

Introduction

The financial technology sector has undergone profound transformation over recent decades, with FinTech companies reshaping payments, lending, wealth management, and regulatory compliance. As these firms grow in influence, stakeholder expectations around Environmental, Social, and Governance (ESG) dimensions have intensified, spanning data privacy, social impact, governance standards, and environmental responsibility. Simultaneously, the regulatory landscape governing ESG in financial services remains fragmented, frequently updated, and inconsistent across jurisdictions, creating significant uncertainty for firms attempting to plan and invest with confidence. FinTech companies occupy a particularly exposed position in this environment. Unlike established financial institutions, they typically combine rapid growth trajectories with leaner organizational structures and historically limited compliance infrastructure. This makes it difficult to absorb the cost and complexity of evolving ESG requirements, particularly when those requirements shift faster than strategic planning cycles allow. The dual pressure of stakeholder expectations and regulatory uncertainty raises a fundamental question: how can FinTech companies implement effective ESG frameworks when the regulatory environment itself is unstable?

Despite growing ESG scholarship in finance broadly, empirical research addressing FinTech-specific ESG implementation challenges remains scarce. Existing literature tends to focus on larger, more established financial institutions operating in comparatively stable regulatory environments, contexts that do not reflect the operational realities of most FinTech firms. This study fills that gap by investigating two interlinked questions: what challenges does regulatory uncertainty create for ESG implementation in FinTech, and how do materiality-driven strategies enable firms to overcome them? The central hypothesis is that FinTech companies adopting materiality-focused ESG strategies, concentrating effort on issues of greatest business and stakeholder relevance, are more effective at navigating regulatory uncertainty and realizing business value than those focused primarily on compliance. The study makes both a theoretical contribution, extending ESG implementation theory to a FinTech context, and a practical one, providing evidence-based guidance for firms and policymakers operating in this space.

Literature Review

A growing body of evidence links ESG performance to long-term organizational outcomes (Eccles, Ioannou and Serafeim, 2014; Friede, Busch and Bassen, 2015), yet scholars caution that mandatory disclosure regimes, such as the EU's Corporate Sustainability Reporting Directive, risk fostering tick-box compliance behaviours rather than substantive ESG integration (Cornell and Damodaran, 2020). FinTech firms face distinct implementation challenges that generic frameworks and current literature fail to capture, including data ethics, digital inclusion, and digital infrastructure footprint (Wang et al., 2023). Institutional Theory further explains ESG adoption as a response to external pressure rather than strategic intent (Meyer and Rowan, 1977), consistent with this study's finding that regulatory uncertainty drives compliance-only behaviours and underscoring the need for materiality-driven strategies as a more effective alternative.

Data and Methodology

Research Philosophy and Design

This study adopts an interpretivist philosophy, emphasizing understanding through the meanings and lived experiences of participants rather than seeking objective, generalizable laws. An inductive approach was applied: data were collected and analysed to allow theory to emerge from patterns in participant experience (Saunders, Lewis and Thornhill, 2019). Grounded theory was selected as the research strategy for its strength in generating theory from empirical data in complex, under-researched settings (Glaser and Strauss, 1967; Strauss and Corbin, 1998). A mono-method qualitative design was employed, relying on semi-structured interviews as the sole data collection instrument, ensuring methodological consistency and depth.

Sample and Data Collection

Ten semi-structured interviews were conducted via video conference over one month (September–October 2025). Participants were selected through stratified purposive sampling to capture diverse stakeholder perspectives across both internal ESG implementers and external advisors. Each session lasted 30–45 minutes, guided by nine open-ended questions targeting ESG challenges and strategic responses. Participants were anonymized as INT1–INT10. Interviews were recorded with consent, transcribed using automated tools, verified for accuracy, and audio files permanently deleted thereafter.

Data Analysis and Trustworthiness

Data were analysed using iterative grounded theory coding: open coding to identify initial concepts, axial coding to establish relationships between categories, and selective coding to develop core themes (Strauss and Corbin, 1998). This process allowed theory to emerge from participant experience without imposing prior assumptions. Trustworthiness was addressed across four dimensions following Lincoln and Guba (1985): credibility through detailed participant profiling; transferability through thick description of the research context; dependability through rigorous

process documentation; and confirmability through systematic researcher reflexivity, including mock interviews and peer review of the interview guide to mitigate bias.

Figure 1 illustrates the three-stage coding process applied in this study, showing how open codes derived inductively from participant data were grouped into axial categories through constant comparative analysis, and subsequently refined into the two core themes reported in Section 4.

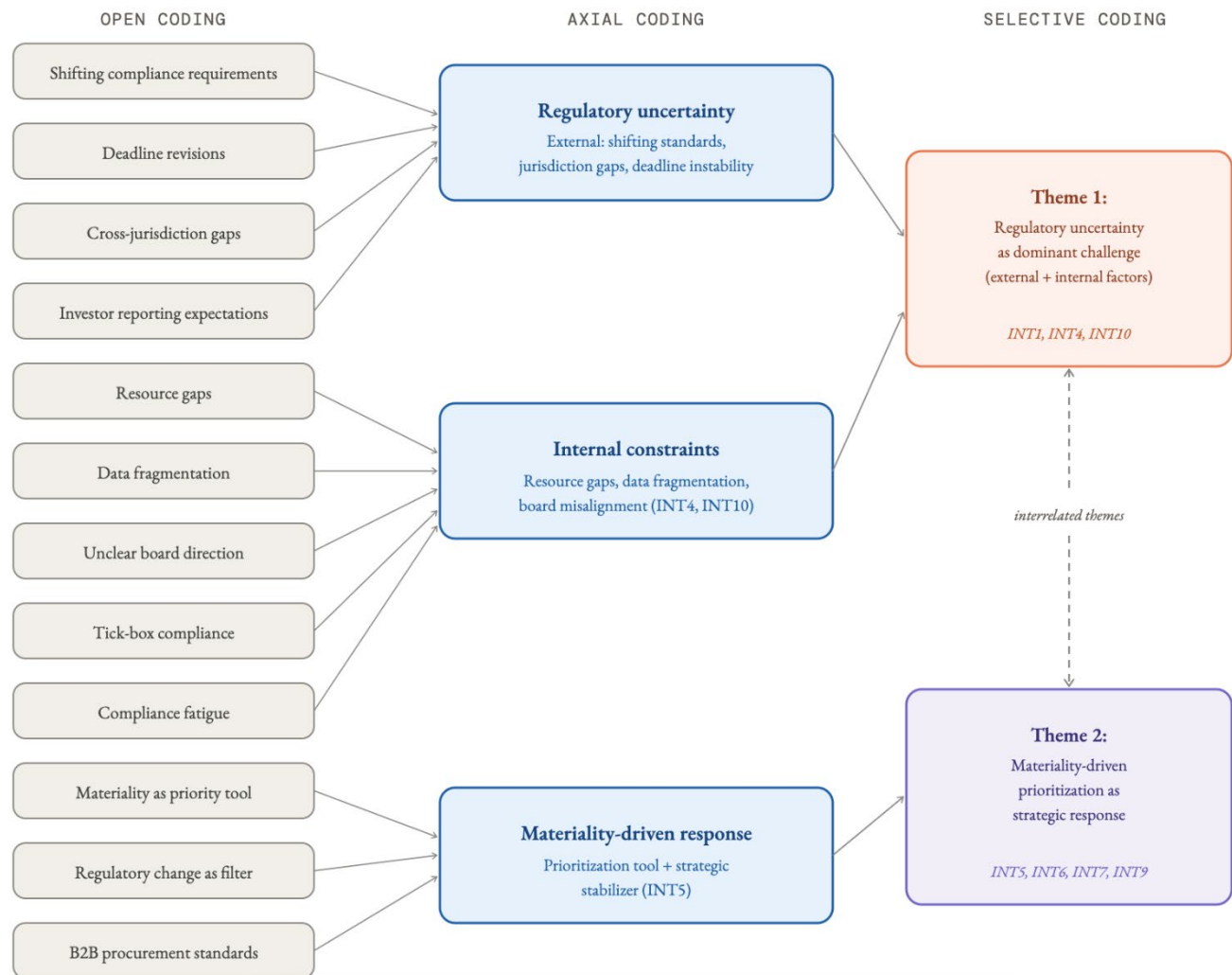


Figure 1. Grounded theory coding structure and emergent themes

Source: Author's own elaboration based on grounded theory coding of semi-structured interviews (Strauss and Corbin, 1998). Open codes are displayed as an unsorted pool; axial groupings emerged inductively. Layout is a simplified representation of an iterative process.

Results and Discussion

Overview of Findings

Analysis of the ten interviews through iterative grounded theory coding surfaced two dominant and interrelated themes: regulatory uncertainty as the defining challenge for ESG implementation in FinTech, and materiality-driven prioritization as the most effective strategic response. These themes were consistent across all participant types, consultants, investors, and corporate ESG personnel, and reinforced by the existing body of literature, though extending it in important ways specific to the FinTech context.

Figure 2 provides a schematic overview of the two themes and their relational structure, illustrating how regulatory uncertainty and its associated internal pressures generate compliance-only

behaviours, while materiality-driven prioritization produces measurable business value beyond compliance.

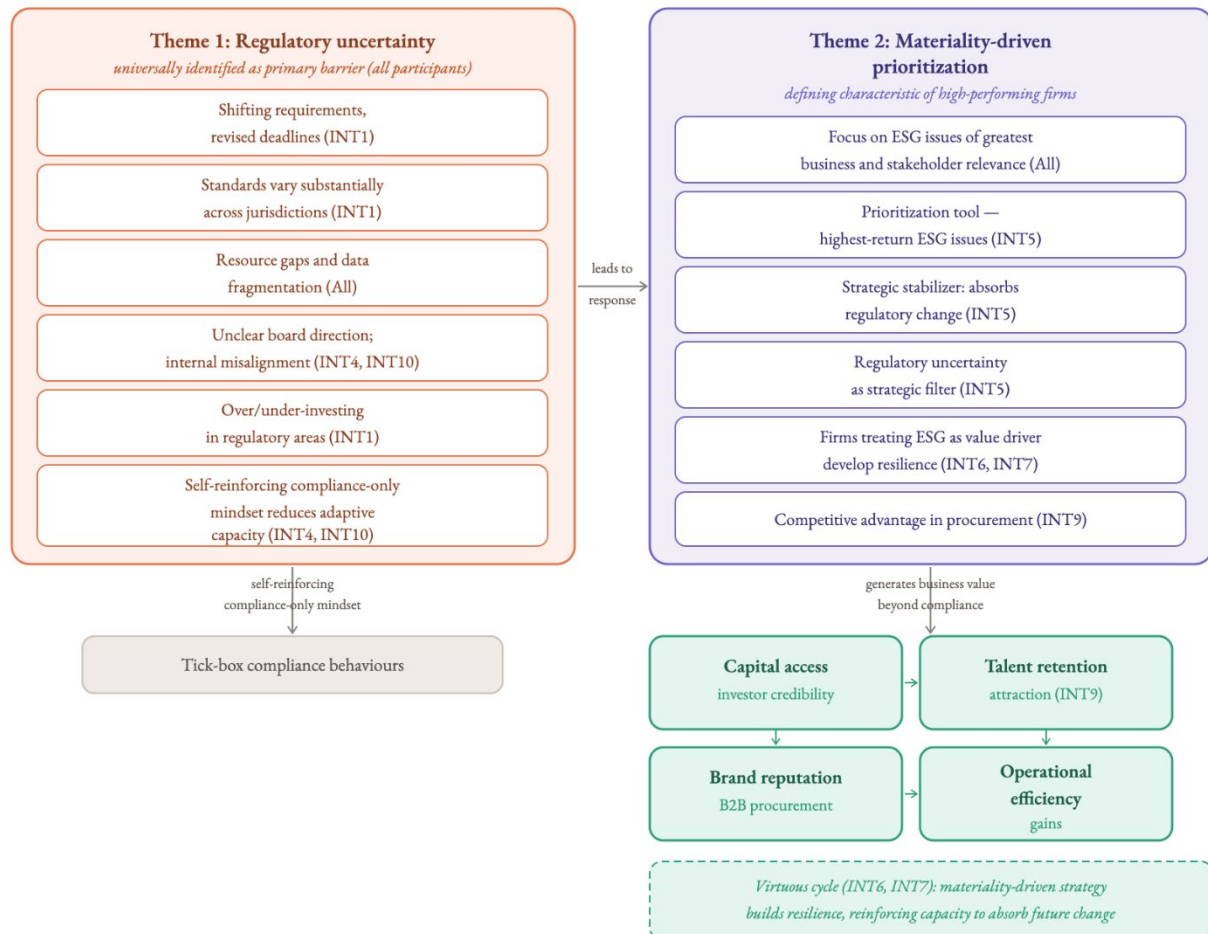


Figure 2. ESG challenges and materiality-driven strategic response: a relational model

Source: Author's own elaboration based on interview data (INT1–INT10, September–October 2025)

Theme 1: Regulatory Uncertainty as the Dominant Challenge

Regulatory uncertainty was universally identified as the primary barrier to effective ESG implementation. Participants described operating against a moving target: ESG requirements shift across reporting periods, deadlines are revised, and standards vary substantially across the jurisdictions in which FinTech firms operate globally. This instability erodes planning capacity, creates compliance fatigue, and makes long-term ESG investment difficult to justify internally. As INT1 noted, firms find themselves simultaneously over-investing in areas that may be deprioritized by future regulation and under-investing in areas that may become mandatory.

This external uncertainty compounds a set of internal pressures that were consistently raised across interviews. Resource gaps and data fragmentation limit firms' ability to meet evolving reporting demands, particularly smaller FinTechs that lack the data infrastructure taken for granted in larger financial institutions. Unclear board-level direction on ESG priorities creates internal misalignment between sustainability functions and business units. The resulting environment encourages superficial, tick-box compliance behaviours, where ESG activity is shaped by what is easiest to report rather than what generates the most value. INT4 and INT10 both emphasized that this compliance-only mindset is self-reinforcing: firms that invest in compliance rather than strategy become less capable of the adaptive thinking needed to respond to regulatory change.

Participants further noted that the challenge extends beyond formal regulatory requirements. Investor reporting expectations, business-to-business customer procurement standards, and evolving industry norms are all moving rapidly, often ahead of regulation, adding multi-directional pressure on firms that lack a coherent ESG strategy to anchor their responses. FinTech firms were consistently described as particularly exposed to this combination of external volatility and internal constraint, given their growth pace, limited compliance infrastructure, and the technology-specific ESG risks, data governance, algorithmic accountability, digital energy use, that add complexity beyond the standard ESG agenda.

Theme 2: Materiality-Driven Prioritization as the Strategic Response

The defining characteristic of high-performing firms, identified consistently across interviews regardless of participant type, was the use of robust materiality assessment as the primary strategic response to regulatory uncertainty. Rather than attempting comprehensive conformity with every emerging requirement, effective organizations invest in identifying the ESG issues of greatest relevance to their specific business model, financial position, and key stakeholder groups, and direct resources accordingly. This materiality-first approach emerged not as a reductive simplification, but as a principled framework for making consequential decisions under uncertainty.

Participants described materiality assessment functioning as both a prioritization tool and a strategic stabilizer. As a prioritization tool, it directs limited compliance and sustainability resources toward ESG actions with the greatest return, whether in terms of risk reduction, investor credibility, talent retention, or operational efficiency. As a strategic stabilizer, it provides a reference framework that absorbs regulatory change: when new requirements emerge, materiality-focused firms can evaluate them against an established set of priorities rather than reacting ad hoc to each development. INT5 described this as transforming regulatory uncertainty from an external threat into a strategic filter, a mechanism for deciding what matters rather than a reason for inaction.

The business value generated by the materiality-focused strategies extended well beyond regulatory compliance. Participants consistently identified improved access to capital, stronger talent attraction and retention, enhanced brand reputation with investors and business-to-business customers, and operational efficiency gains as direct outcomes of credible, targeted ESG performance. INT9 observed that firms demonstrating strategic, materiality-grounded ESG credentials increasingly command a competitive advantage in markets where ESG performance influences procurement and investment decisions. INT6 and INT7 noted that firms treating ESG as a genuine value driver rather than a compliance cost develop organizational resilience that makes them better placed to absorb future regulatory change, creating a virtuous cycle between materiality-focused strategy and adaptive capacity.

Conclusions

This study demonstrates that regulatory uncertainty is the defining challenge for ESG implementation in FinTech, and that materiality-driven prioritization is the most effective strategic response available to firms in this environment. The findings confirm the central hypothesis: FinTech companies anchoring ESG decisions in robust materiality assessment, focusing resources on issues of greatest business and stakeholder relevance, achieve stronger ESG integration and generate measurable value beyond compliance, outperforming peers whose ESG activity is shaped primarily by regulatory minimums.

The theoretical contribution of this study is an empirically grounded account of how regulatory uncertainty shapes ESG adoption in FinTech, and how materiality functions simultaneously as a prioritization tool and a strategic stabilizer under conditions of regulatory flux. This extends existing ESG implementation theory, which has largely assumed stable regulatory contexts and larger organizational capacity, to a sector where neither condition holds. The findings also highlight the compounding effect of external regulatory uncertainty and internal organizational constraints,

resource gaps, data fragmentation, and compliance-only mindsets, as a distinctive dynamic of FinTech ESG implementation not well captured in existing literature.

For practitioners, the key implication is to invest early in materiality assessment and build phased, flexible compliance frameworks designed to evolve as regulatory clarity improves, rather than attempting to satisfy every current requirement comprehensively. For policymakers, the findings underscore the disproportionate cost that regulatory fragmentation and instability impose on smaller, fast-growing firms, a cost that undermines the very ESG adoption that regulation seeks to promote. Greater cross-jurisdictional harmonization and longer regulatory lead times would substantially reduce this burden.

Limitations and Future Research

Notwithstanding these contributions, several limitations should be acknowledged. The sample of ten participants, while appropriate for a grounded theory design oriented toward theoretical saturation, limits the transferability of findings to broader FinTech populations. The study does not claim representativeness, and participants were drawn primarily from consulting, private equity, and corporate ESG roles, meaning variation across firm size, jurisdiction, and sub-sector within FinTech remains unexplored. The mono-method qualitative design further means that the proposed relationships between regulatory uncertainty, materiality-driven strategy, and business value outcomes represent conceptual rather than causal claims.

Future research should address these limitations through quantitative investigation. Survey-based studies measuring the relationship between materiality assessment maturity and ESG performance outcomes across a diverse sample of FinTech firms would allow the theoretical model developed here to be tested at scale. Comparative cross-jurisdictional research examining how different regulatory environments shape FinTech ESG adoption and longitudinal designs tracking how firms' strategies evolve as regulatory clarity improves would further extend the adaptive capacity dynamics identified in this study.

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DIGITALIZATION OF HR PROCESSES IN SMEs BASED ON THE EMPLOYEE LIFECYCLE MODEL

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Abstract: *The study explores the digitalization of human resource (HR) processes in small and medium-sized enterprises (SMEs) through the lens of the Employee Lifecycle model. The aim of the research is to assess the potential for integrating digital tools across different stages of employee management and to identify practical mechanisms that enhance organizational efficiency under resource constraints. The methodological framework combines a theoretical review of the Employee Lifecycle concept and digital HR transformation with a qualitative case study of a small enterprise operating in the Republic of Moldova.*

The analysis demonstrates that digital tools, such as online recruitment platforms, cloud-based documentation, task management systems, and ERP solutions, can significantly improve the efficiency, transparency, and coordination of HR processes in SMEs. At the same time, the findings reveal an uneven level of digitalization across lifecycle stages: while performance management and operational coordination are relatively well digitalized, earlier stages such as recruitment, onboarding, and employee development remain less formalized.

The study highlights the dual nature of digitalization, emphasizing both its benefits such as reduced transaction costs, improved data-driven decision-making, and increased flexibility, and associated risks, including data security concerns, over-reliance on digital tools, and potential decline in interpersonal interaction. The results suggest that the effectiveness of digital HR in SMEs depends not on the number of technologies adopted, but on their integration into a coherent management system aligned with the Employee Lifecycle model.

Key words: digitalization, HR management, SMEs, employee lifecycle, ERP systems

JEL: M12, O33, L26

Introduction

The Employee Lifecycle Model is a modern conceptual framework for human resource (HR) management that describes the sequential stages of interaction between an employee and an organization from attraction and onboarding to development, retention, and separation. Unlike the traditional approach focused on individual HR functions, this model views an employee's professional journey as an integrated system of interrelated processes, where the quality of management at each stage affects overall engagement, productivity, and organizational sustainability (Cohen, 2010). Contemporary research emphasizes that the Employee Lifecycle reflects not only the administrative sequence of HR procedures but also the dynamic interaction between employee and employer, based on the alignment of expectations, motivation, and organizational goals (Gürler et al, 2022). In this context, the importance of employee experience increases, as it reflects the cumulative experience of individuals across all stages of their interactions with the company and directly influences employee loyalty, turnover, and work performance. Digital transformation has significantly reshaped HR processes. The use of digital platforms, HR analytics, cloud services, and artificial intelligence tools enables the automation of routine operations, accelerates decision-making, and enhances the accuracy of workforce management (Sharma, 2022; Xiang et al., 2023). Digital transformation in HR management represents not merely the adoption of new technologies, but a fundamental shift toward data-driven, integrated, and strategically oriented workforce management systems (Sani et al. 2024; Sakib et al. 2025; Srivastava (2026). The future of human resource

management is increasingly shaped by the integration of digital technologies, which enhance efficiency while requiring new competencies and adaptive organizational practices (Muzanenhamo and Rankhumise, 2025).

As a result, digitalization is becoming a key factor in enhancing organizational efficiency and competitiveness. For small and medium-sized enterprises (SMEs), the importance of these processes is particularly significant. Under conditions of limited financial and human resources, human capital becomes one of the main drivers of business sustainability and growth.

At the same time, the implementation of digital HR tools in the SME sector is constrained by limited investment capacity, a lack of specialised competencies, and the absence of formalised HR structures. This necessitates adapting modern solutions to the scale of small businesses and identifying accessible models for the digitalization of workforce management. Unlike large corporations, the issue of systematic digitalization of HR processes in SMEs remains insufficiently explored.

The aim of this study is to analyze the potential for digitalizing HR processes in small and medium-sized enterprises based on the Employee Lifecycle model, as well as to identify practical mechanisms for integrating digital tools into human resource management.

Methodological framework

The study is based on a combination of theoretical analysis and a case study approach, which made it possible to examine the digitalization of HR processes in small and medium-sized enterprises from both conceptual and practical perspectives. In the first stage, an analysis of the academic literature on the Employee Lifecycle model, the digital transformation of HRM, and the specifics of personnel management in SMEs was conducted. This made it possible to systematize the stages of the employee lifecycle and the tools for their digitalization, as well as to identify key advantages and risks.

In the second stage, a case study of Bravomotors SRL (Republic of Moldova) was used: a small enterprise in the automotive service sector with more than 10 years of experience and a staff of 12. The case was selected as representative of SMEs operating under resource constraints and without a dedicated HR department. The study is qualitative in nature. The author's involvement in the company's activities provided access to internal documentation and ERP data, as well as direct observation of management.

The Employee Lifecycle Approach

Life cycle management represents a systemic approach that considers processes and impacts across all stages of a system's development, ensuring coherence, efficiency, and long-term sustainability (Massari et al., 2023). Various versions of the employee lifecycle model are identified; however, most researchers agree on key phases, including attraction, onboarding and development, performance management, and employee retention (Gladka et al., 2022; Nosratabadi et al., 2022; Wandhe, 2025).

Despite differences in the level of detail and naming of stages, these approaches demonstrate conceptual unity in understanding the core processes of interaction between the employee and the organization. This allows the employee lifecycle to be considered a universal model applicable across different organizational contexts. For SMEs, implementing these stages is particularly important, as limited resources require more precise and efficient management at each stage of employee interaction.

The Attraction stage involves building an appealing employer brand and sourcing potential candidates. At this stage, the organization seeks to attract specialists through brand reputation, digital communication channels, and transparency of company values. For SMEs, this stage is especially critical, as the entrepreneur often acts as the main "employer brand," while digital tools enable competition with large companies without significant costs.

The use of online recruitment platforms (Rabota.md, LinkedIn) provides entrepreneurs with quick access to a broad labor market without the need to establish a full HR function, which is especially important for small businesses (*Table 1*). However, this is accompanied by the risk of online screening errors due to limited information and the absence of in-depth candidate evaluation. At the same time,

this format may lead to superficial candidate assessment due to the lack of in-person interaction and limited opportunities for comprehensive competency evaluation.

Table 1. Attraction & Recruitment Management

Process	Practical Digitalization in SMEs	Entrepreneurial Value	Risks
Candidate Search	Rabota.md, LinkedIn, online job postings	Fast access to the labor market without an HR department	Online screening errors
Online Interviews	Zoom, Google Meet	Time savings for the entrepreneur	Superficial candidate assessment

Source: developed by the author

After hiring, the employee development stage begins, including onboarding, training, and professional skill development. Studies show that effective onboarding significantly reduces the likelihood of early turnover and accelerates productivity gains. Employee development is considered a key element of human capital theory, as investments in training increase productivity and the long-term value of employees for the organization.

In the context of digitalization, this stage involves online learning, digital knowledge bases, and continuous feedback. *Table 2* presents selected aspects of the digitalization of onboarding and employee development stages in SMEs, allowing for an assessment of the balance between the benefits gained and the risks involved. For example, during onboarding, the use of digital tools (such as instructions in Google Docs and checklists) ensures rapid integration of employees into work processes and standardization of adaptation. However, there is a risk of insufficient socialization, as digital formats do not always facilitate the development of informal relationships within the team.

In terms of training, the use of online courses and recorded meetings enables skill development with minimal costs, which is especially relevant for SMEs. At the same time, this format may reduce employee engagement due to limited interaction and reliance on self-discipline. Knowledge sharing through shared folders and templates helps preserve organizational knowledge and simplifies access to information. However, it also increases the risk of knowledge leakage, particularly when access controls are insufficient or employee turnover is high.

Table 2. Onboarding & Development

Process	Practical Digitalization in SMEs	Entrepreneurial Value	Risks
Onboarding	Google Docs instructions, checklists	Fast employee integration	Lack of socialization
Training	Online courses, Zoom recordings	Skill development at low cost	Low engagement
Knowledge Transfer	Shared folders, templates	Preservation of team knowledge	Knowledge leakage

Source: developed by the author

The Performance stage involves evaluating work results, developing competencies, and maintaining employee engagement (*Table 3*). Employee engagement should be understood as a dynamic, lifecycle-based process that evolves across different stages of the employee–organization relationship, rather than as a static organizational outcome Kwon and Park (2019). It includes goal setting, regular feedback, and productivity analysis. From a strategic HR perspective, this stage performs several functions: aligning employee and business goals, sustaining motivation, and identifying development needs.

In a digital environment, performance management increasingly relies on data analytics and agile approaches, enabling faster decision-making with reduced risks. Digital task management tools (such as Trello, Notion, and spreadsheets) enhance transparency and control, which is especially important for SMEs; however, their excessive use may lead to employee overload. Messaging platforms (Telegram, Slack) provide flexibility and speed of communication, but may weaken personal interaction and workplace relationships. Feedback tools (online surveys, instant feedback) increase engagement, yet excessive formalization can reduce the authenticity and depth of communication.

Table 3. Performance & Engagement Management

Process	Practical Digitalization in SMEs	Entrepreneurial Value	Risks
Task Management	Trello, Notion, spreadsheets	Team transparency	Digital overload
Communication	Telegram, Slack	Flexibility of distributed teams	Loss of personal contact
Feedback and Motivation	Online surveys, instant feedback	Employee retention	Formalization of communication

Source: developed by the author

Feedback and motivation tools (such as online surveys and instant feedback) contribute to employee retention, but may also lead to the formalization of communication (*Table 4*). The next stage of the model focuses on building long-term relationships with employees through motivation, development, and a positive work experience. Systematic management of the employee lifecycle reduces turnover and increases engagement (Amarakoon and Colley, 2023), a pattern that is particularly important for SMEs. Basic HR analytics tools (such as Excel and Google Sheets) support more informed decision-making; however, a lack of expertise may lead to analysis errors. Digital forecasting tools simplify team growth planning and cost control, but inaccurate forecasts can negatively affect HR and financial policies. The digitalization of document management reduces bureaucracy and streamlines processes, although it is accompanied by risks related to cybersecurity and data protection.

Table 4. Retention & Administration

Process	Practical Digitalization in SMEs	Entrepreneurial Value	Risks
Basic HR Analytics	Excel, Google Sheets	Data-driven decision-making by the entrepreneur	Analysis errors
Team Growth Planning	Forecasting in spreadsheets	Cost control	Inaccurate forecasts
Document Management	Electronic contracts, cloud documents	Reduced bureaucracy	Cybersecurity risks

Source: developed by the author

The development of competencies through online courses, webinars, and LMS platforms enables small enterprises to significantly enhance employees' qualifications without substantial financial costs, which is an important advantage (*Table 5*). At the same time, there is a risk of a formal approach to training, where development does not always lead to a real improvement in competencies.

Table 5. Professional Development Management

Process	Practical Digitalization in SMEs	Entrepreneurial Value	Risks
Career Planning	Online development platforms, individual plans	Increased employee loyalty	Limited career opportunities
Competency Development	Online courses, webinars, LMS platforms	Skill growth at low cost	Formal approach to training
Internal Promotion	Internal job databases, digital employee profiles	Talent retention	Limited positions in SMEs

Source: developed by the author

The separation stage is an important part of the employee lifecycle, as it allows the organization to systematize the offboarding process, retain accumulated knowledge, and maintain a positive employer image. A well-structured separation stage helps not only to minimize the loss of human capital but also to build long-term relationships with former employees, which can be important for reputation and future talent attraction.

Case study

A practical analysis of the Bravomotors SRL, which operates without a dedicated HR department, enables a comparison between the theoretical employee lifecycle model and real HR management practices in SMEs. In this case, HR functions are integrated into a unified ERP system that also serves as a CRM and employee database. This enables the centralized accumulation and analysis of information on both clients and staff, implementing the principles of data-driven management. Within the ERP system, a digital profile is created for each employee, where key performance indicators (KPIs) are recorded. For technical staff (auto mechanics), metrics such as worked labor hours, volume of completed tasks, number and nature of complaints, as well as errors and rework with specified causes and circumstances are tracked. For administrative and commercial staff (service advisors, managers, parts specialists), the system currently primarily captures quantitative indicators, such as sales volume and order participation (*Table 6*).

Table 6. Digital Management Tools of Bravomotors SRL

Process	Tool	Practical Application	Entrepreneurial Value
Work Planning	Calendars	Client booking, workload scheduling	Work transparency
Coordination	Schedules	Alignment of shifts and employee tasks	Reduced downtime
Task Management	Task managers (Trello-like)	Assigning tasks within the team	Control of execution and accountability
Training and Professional Development	Electronic catalogues, GPT chat	Consultation and learning approaches for complex repair cases	Employee development, problem-solving
Motivation	ERP – cost of work/number of hours	Transparency of wage calculation	Employee motivation and control

Source: developed by the author

Additionally, the ERP system integrates operational management tools, including calendars, schedules, and task managers. Task managers operate based on project management principles (similar to Trello), enabling the assignment of client-related tasks, documentation of agreements, tracking of task completion, and minimizing information loss within the team.

Bravomotors SRL successfully implements certain elements of digitalization at key stages of the Employee Lifecycle; however, the level of their integration and systematic application remains uneven. At the same time, traditional approaches are still used to manage some stages of the employee lifecycle. For example, in recruitment, particular emphasis is placed on interviews, during which candidates' professional competencies are assessed. The implementation of digital tools has enabled Bravomotors SRL to achieve a number of significant organizational effects. The use of calendars, schedules, and task management systems has helped reduce employee downtime and ensure a more balanced workload distribution. Recording employee performance indicators in the ERP system has improved KPI transparency and objectivity in performance evaluation, thereby enhancing overall business manageability. Digital monitoring of tasks and operations has strengthened execution discipline and improved control over internal processes. Transparent mechanisms for calculating service costs and employee compensation have helped reduce conflicts between management and staff related to income distribution and performance assessment. A unified information environment has accelerated data exchange between departments and enabled efficient coordination of employee

activities, which is particularly important for a small enterprise with limited resources. Thus, the digitalization of HR and operational processes has contributed to improving overall workforce management efficiency and organizational sustainability.

The analysis of Bravomotors SRL shows that the highest level of digitalization is observed in the stages of performance management and operational coordination, which aligns with modern approaches to productivity management and indicates a relatively high level of digital maturity in the operational domain. At the same time, the stages of attraction, onboarding, and career development are implemented in a less formalized manner and largely depend on the managerial decisions of the entrepreneur.

Conclusions

The presented systematization demonstrates that the digitalization of HR processes in SMEs has a dual nature. On the one hand, it helps reduce transaction costs, enhances organizational flexibility, and enables entrepreneurs to manage human capital more effectively, even with limited resources. On the other hand, digital tools introduce new institutional and organizational risks related to data security, the algorithmization of managerial decision-making, and the transformation of corporate culture. At the same time, HR practices in SMEs are shaped by organizational scale and local context, resulting in more flexible and relationship-based approaches to employee attraction and retention (Amarakoon and Colley, 2023).

In this context, digital HR in the SME sector should be viewed as a balance between improving business efficiency and managing digital risks. However, as practice shows, the effectiveness of digitalization is determined not by the number of implemented technologies, but by the degree of their integration into a unified enterprise management system and their ability to support key business processes.

The practical case of Bravomotors SRL demonstrates that even in a small enterprise, it is possible to implement comprehensive elements of digital HR management without a dedicated HR department. The integration of an ERP system, data analytics, and operational control tools enables the development of an effective human resource management system. At the same time, further efficiency improvements require a shift from fragmented automation of individual functions to an integrated employee lifecycle management model, ensuring consistency across all stages of employee interaction and reducing managerial risks.

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FREQUENT CHALLENGES IN CRM IMPLEMENTATION AND PRACTICAL SOLUTIONS FOR SMALL AND MEDIUM-SIZED ENTERPRISES

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Abstract: *This study examines the implementation of Customer Relationship Management (CRM) systems in small and medium-sized enterprises (SMEs) and their impact on customer management, sales performance, and marketing efficiency. The main objective of the research is to identify how CRM solutions contribute to improving communication with customers, optimizing business operations, and increasing customer loyalty. The study also explores the importance of automation, employee training, and system integration in achieving successful CRM adoption within SMEs. The methodology is based on qualitative analysis, including case studies, secondary data analysis, and the evaluation of CRM implementation practices in different SMEs. The research investigates the challenges companies face during CRM integration and the strategies used to improve operational efficiency and customer relationship management. Particular attention is given to the role of digital tools in organizing customer information, tracking interactions, and supporting decision-making processes.*

The findings indicate that effective CRM implementation leads to better customer satisfaction, improved lead management, increased sales productivity, and stronger long-term relationships with clients. In addition, the results show that SMEs that invest in staff training and automation achieve higher operational performance and more efficient marketing activities. The study concludes that CRM systems represent an essential strategic tool for SMEs seeking sustainable growth, competitive advantage, and improved business performance in a dynamic market environment.

Key words: CRM, Digitalization, Customer Relationship Management, Data Centralization, Automation.

JEL: M31, O33, C83

Introduction

Implementing a CRM system within SMEs brings significant benefits; however, the process is often accompanied by a range of challenges that can affect the final outcomes. Among the most common are the lack of a clear strategy, employee resistance to change, poor data quality, difficult integration with other systems, underutilization of functionalities, insufficient training, and ineffective performance monitoring. Without a well-defined vision, a CRM system risks becoming merely a technical tool with no real impact on the business. Therefore, it is essential that the implementation be guided by concrete objectives aligned with the company's sales and marketing strategy.

Another major challenge is team adoption of the system. Employees may perceive the CRM as an additional task, leading to superficial or incorrect usage. The solution lies in practical training, clear communication of the benefits, and involving the team throughout the implementation process. At the same time, companies must pay close attention to the quality of the data entered into the system, as incomplete or inaccurate information compromises analysis and future decision-making. Standardizing data collection and update processes thus becomes essential.

Integrating the CRM with other digital tools (such as email marketing platforms, ERP systems, and sales platforms) represents another common difficulty. Choosing a compatible solution and conducting phased testing can help prevent technical bottlenecks. Furthermore, many SMEs fail to use the full potential of the system, limiting themselves to basic functionalities. It is therefore recommended to configure automated workflows and make use of analytical reports for the continuous optimization of business processes.

CRM system usage guidelines remain fundamental to successful implementation, as they provide a clear framework for centralizing customer data, improving customer experience, and increasing customer loyalty. At the same time, they contribute to streamlining sales and marketing activities and supporting data-driven decision-making. By combining operational best practices with practical solutions for each of these challenges, companies can maximize the value of CRM technology, adapt quickly to market dynamics, and strengthen their competitive advantage.

The implementation of a CRM system is a complex, long-term project with real risks involved. Even when the technology is successfully installed, the outcomes may still be disappointing due to common implementation mistakes. Below are the seven classic errors frequently observed in practice, each accompanied by recommendations that should be incorporated into the company's internal guidelines to ensure successful implementation.

1. CRM Implemented by Programmers Instead of Sales Specialists

In many companies, CRM implementation becomes a technical project managed almost exclusively by the IT department. On paper, this seems logical: those who build the software should also implement it. In practice, however, this approach creates a significant gap between the system's capabilities and the actual needs of the sales team — a gap that can compromise the entire project.

The core issue is that when decisions regarding the CRM structure, workflows, and priorities are made primarily from a programming perspective, the result is technically correct IT solutions that are poorly adapted to the way people actually sell. The outcome: unnecessary functionalities, complicated interfaces, procedures that slow down workflows, low user adoption, and a failure to achieve the expected business value.

Common causes:

-Organizational predisposition: management automatically delegates the project to the IT department, viewing software development as purely a technical matter.

-Lack of user consultation: sales representatives are involved only in formal stages and do not actively contribute to process design.

-Poor communication: different terminology and unspoken expectations lead to incorrect interpretations in the specifications.

-“Build-first” approach: priority is given to delivering code rather than validating commercial usefulness.

How this blocks implementation success:

- Low adoption rate: salespeople avoid the system, continue using spreadsheets or personal notes, and data becomes inaccurate.
- Duplicate work and errors: processes designed without practical business insight create repetitive tasks and operational mistakes.
- Weak ROI: significant investments in development fail to generate sales growth because the functionalities do not support commercial decision-making.
- Delays and additional costs: repeated reconfigurations, scope changes, and ad-hoc developments increase both the budget and implementation timeline.

Warning signs that the project is at risk:

- Frequent requests for “fixes” from the sales team after launch.
- Complex reports remain unused, while mandatory fields are ignored.
- A decline in the number of activities recorded in the CRM compared to unofficial tracking methods.
- Ongoing friction between IT and sales regarding priorities.

Practical solutions: Mixed Project Team

- Establish a project team that includes representatives from sales, IT, operations, and management.

- Appoint a product owner from the sales department responsible for functional priorities and deliverable approval.

2. Customer and Transaction Data Is Not Recorded

In practice, one of the most frequent and damaging CRM implementation flaws is the data gap: customer records remain incomplete, transactions are not properly logged, and information stays fragmented across personal notes or Excel files. Essentially, the system exists, but its "heart" — the data — is not functioning. Without accurate data, the CRM cannot support decision-making, automation, or personalized customer relationships.

Common causes

- Perceived time cost: managers and sales agents see filling in customer records as an administrative task that takes time away from selling.
- Poorly designed forms: long cards, irrelevant or redundant fields discourage complete data entry.
- Lack of automation: data that could be captured automatically (emails, calls, web forms) is entered manually.
- Weak organizational culture: there are no clear rules, responsibilities, or incentives/sanctions for proper data entry.
- Missing feedback loop: users do not immediately see the practical value of entered data (reports, qualified leads, segmentation).

How it blocks project success

- Incorrect analysis: decisions based on incomplete data lead to wrong strategies (poor targeting, inefficient forecasting).
- Ineffective automation: triggers and campaigns fail because they lack the necessary data to function properly.
- Lost opportunities: follow-ups are delayed, clients remain unattended, or receive irrelevant communication.
- Low adoption: management loses trust in the CRM, and users return to parallel tools (Excel, notes).
- Hidden costs: data re-entry and cleanup consume additional time and resources.

Clear signs that data is not properly recorded

- High proportion of incomplete customer records or inactive accounts.
- Mismatch between real activity reported by managers and CRM records.
- Low-performing campaigns due to incorrect segmentation.
- Frequent billing or follow-up errors caused by missing transaction history.

Step-by-step implementation (mini roadmap for instructions)

- Phase 1: Define minimum required fields and implement validation rules.
- Phase 2: Add automated capture for emails/calls and web form integration.
- Phase 3: Run a pilot with a sales team, monitor data quality, and collect feedback.
- Phase 4: Scale up, provide full training, monitor KPIs, and make periodic adjustments.

3. Excessively Long Development (10+ months)

Problem

Custom CRM projects often extend over long periods and exceed budgets, delaying benefits and generating additional costs.

How it blocks success

Delayed launch reduces trust, increases expenses, and makes ongoing business changes incompatible with the system under development.

Practical solution

Launch an MVP (Minimum Viable Product) quickly using a standard cloud solution; measure clear results within the first 3 months, then prioritize customizations in stages based on proven impact.

4. Lack of Training Programs and Materials

Problem

There are no structured materials, rules, or responsible trainers; new employees learn in an unstructured way, consuming colleagues' time.

How it blocks success

Slow and incorrect adoption leads to poor-quality data and reduces the perceived value of the CRM.

Practical solution

Create a standard onboarding package: 3 short videos (introduction, main workflow, daily tasks) plus a 7-step checklist for the first week. A designated super-user should be responsible for delivery.

5. CRM Used Only as a Database (Like Excel)

Problem

The CRM becomes a passive registry without active processes for increasing sales.

How it blocks success

Without clear use cases and scenarios, the system does not influence conversion, retention, or upselling; lack of ROI leads to abandonment.

Practical solution

Define one priority use case (e.g., increasing follow-up rate within 14 days) and configure dedicated automations and reports for it. Measure results and expand gradually.

6. Incompatibility with Accounting and Other Systems

Problem

Lack of integration leads to duplicate work, errors, and information loss (e.g., accounting system integration issues).

How it blocks success

Parallel workflows discourage CRM usage, increase administrative time, and create data inconsistencies.

Practical solution

Conduct a preliminary technical audit: list required fields and synchronization frequency, then implement a standard connector or middleware for automated synchronization with clear reconciliation rules.

7. Recommended Operational Elements for Internal Procedures

Problem

Lack of a structured activity list leads to unfocused work: wasted time, unclear priorities, and high variability in productivity.

How it blocks success

Without a shared plan, monitoring, and motivation alignment, performance becomes unpredictable; KPIs fluctuate, pipelines weaken, and management cannot intervene effectively.

Practical solution

Define a standardized daily plan with 4–6 measurable core actions (e.g., 25 outbound calls, 8 follow-ups, 2 scheduled meetings, 2 sent offers). A daily checklist is completed in the CRM, and performance directly influences variable bonuses.

Table 1. Monitoring structure — example table (daily monitoring and responsibilities)

Indicator / Activity	Daily target	Source / CRM tool	Responsible	Alert if not achieved
Outbound calls	25	Call log CRM	Manager	>30% below target
Follow-up (email/task)	8	Task list CRM	Manager	>40% below target
Offers sent	2	Documents CRM	Manager	0 offers/day
New lead sign-ups	3	Lead form / integrations	Marketing	<1 lead/day
Client card updates	100% of interactions	Card activity	Manager	any interaction not recorded
Pipeline total value	—	Pipeline dashboard	Head of Sales	drop >10% wk.
Invoices issued	—	ERP/CRM integration	Finance	daily discrepancies

Source: Author's elaboration.

Rapid implementation:

- Configure KPI dashboard in CRM (1 week).
- Publish checklists and SLAs in the knowledge base (2 days).
- Run a 4-week monitoring pilot, adjust processes and regulations.

A clear set of operational procedures — daily planning, automated reporting, short coordination rituals, and control policies — transforms the CRM from a storage space into a sales engine. The disciplined implementation of these elements ensures data quality, real adoption, and predictability of commercial performance.

Conclusions

Implementing a CRM system represents, in essence, an organizational change just as much as it is a technological investment. The conclusions presented in this material—referring to the need for a daily activity plan, automated reporting and monitoring, short coordination meetings, as well as clear regulations and sanctions—are not merely operational best practices, but fundamental requirements for transforming CRM from a simple data repository into a real engine for generating commercial value.

Three central ideas emerge from the proposed analysis. First, operational discipline. Without standardized and verifiable procedures, the sales team's activity remains uncoordinated, and the data in the CRM becomes incomplete or inaccurate. A clear daily plan, with measurable actions and verification tools, reduces performance variability and enables rapid intervention from management. Second, reporting infrastructure and analysis. Automated reports and real-time dashboards are essential for identifying deviations, allocating resources, and making tactical decisions. They transform the data entered into the CRM into useful insights, which are essential for optimizing conversions, planning the sales pipeline, and evaluating campaign efficiency.

Third, decision rhythm and a culture of accountability. Short daily routines and weekly meetings ensure team alignment on immediate objectives, while a clear set of rules, together with proportional consequences for non-compliance, enforces the discipline necessary to maintain data quality and desired behaviors.

The effectiveness of these measures does not depend exclusively on technology, but rather on their integration into a coherent managerial framework: the designation of responsible roles (super-users, commercial product owner), transparent communication of expectations, and linking performance indicators to motivation systems. In practice, the most successful CRM projects combine appropriate technological solutions with clear processes, systematic training, and data governance mechanisms. These conclusions are also supported by best practices documented in the professional literature. Studies and reports from management and technology consulting—including analyses on data monitoring, change management, and software adoption in companies—confirm that CRM projects with well-defined and measurable operational processes have a significantly higher probability of delivering ROI. General business recommendations (MVP phase, piloting, iterations, clear ownership roles) are frequently mentioned in professional guides from research and consulting firms and align with practical market experience.

In conclusion, transforming CRM into a strategic tool requires consistency: setting rules, enforcing them, monitoring results, and continuously adjusting based on data. Adopting the proposed model—combining daily planning, automated reporting, structured work rhythms, and a clear regulatory framework—offers the most direct path toward improving commercial performance, increasing data quality, and maximizing the value of the technology investment. Through rigorous implementation and active monitoring, CRM ceases to be an administrative burden and becomes a concrete instrument for growth and predictability for the business.

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EDUCATION FOR GENDER EQUALITY – A PREMISE FOR THE MODERNIZATION OF RURAL COMMUNITIES

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Abstract: *Education for gender equality represents an essential tool for the modernization and sustainable development of rural communities. In the Republic of Moldova, rural areas face persistent challenges such as limited access to quality education, deeply rooted traditional stereotypes, and the reduced participation of women in social, economic, and decision-making processes. This study examines the role of education in promoting gender equality and its impact on the modernization of rural communities. The methodology includes the analysis of educational programs and policies, case studies conducted in several rural localities, as well as interviews with teachers, students, parents, and community leaders.*

The results indicate that education for gender equality increases awareness of equitable roles and responsibilities between women and men, stimulates the active participation of women in community initiatives, and contributes to the gradual reduction of traditional stereotypes. Furthermore, educational programs focused on gender equality foster the development of leadership skills, entrepreneurial spirit, and cooperation among community members. These outcomes also support improved social cohesion and local development.

The study concludes that education for gender equality not only supports social inclusion but also becomes a fundamental premise for the modernization, resilience, and long-term sustainability of rural communities in the Republic of Moldova, offering valuable directions for future policies and community-based interventions.

Keywords: *gender equality, gender education, rural development, economic, empowerment, gender-based violence*

JEL Classification: J16

Introduction

Gender equality education represents a fundamental premise for the modernization of rural communities in the Republic of Moldova, acting as a catalyst for sustainable development, social inclusion, and economic growth. Although women in rural areas play a crucial role in agriculture and household management, they continue to face deeply rooted gender stereotypes, an unequal distribution of domestic labor, and limited access to resources and decision-making processes. Education must serve as one of the fundamental pathways for correcting social inequalities, including those based on sex, thereby contributing to the construction of a free and democratic society.

Gender education is also education for private life—an approach that should be encouraged within the school environment from the earliest years of study. A child's self-image in relation to gender is formed at an early age through the internalization of social models of interaction between groups, shaped both by parental influence and reinforced by peer groups. What defines us as women or men is the result of a long process of social learning, taking place within the family, among friends, at school, and in other social contexts.

As social structures, educational institutions at all levels represent important laboratories for the construction of gender identities among students. From this perspective, the way learning experiences are organized—through both their explicit and implicit content, as well as through the cognitive activities and social interaction models they promote—can significantly influence gender awareness, internalization, and the adoption or exercise of gender roles.

Rural development is one of the major priorities of contemporary societies, especially in the context of globalization and the need to adapt to modern standards of living. In the Republic of Moldova, rural areas continue to face multiple challenges, including limited access to economic resources, labor migration, and the persistence of traditional social norms that influence the distribution of roles within communities.[1]

In this context, gender equality and gender education become essential factors in the process of rural modernization. Promoting the equal participation of women and men in economic, social, and political life not only aligns with fundamental human rights principles but also contributes to increased economic efficiency and strengthened social cohesion. Initiatives implemented by international and national organizations, such as the United Nations Development Programme and UNFPA Moldova, demonstrate that integrating a gender perspective into local policies and practices generates concrete and sustainable results.

This article aims to analyze the role of gender education and gender equality in rural development, highlighting their impact on the local economy, on transforming mindsets, and on preventing social phenomena such as gender-based violence. Through an integrated approach, the paper seeks to argue for the necessity of including a gender perspective as a central element in rural development strategies.

At the same time, the article examines the impact of gender education on local economic development through women's empowerment, the stimulation of rural entrepreneurship, and the sustainable use of resources. Another aspect analyzed is the role of men's involvement in promoting gender balance and in redistributing family responsibilities.

Additionally, the paper explores community initiatives and projects aimed at preventing gender-based violence, including programs supported by organizations such as UNFPA Moldova, which contribute to the creation of safer and more inclusive communities. Through this analysis, the article seeks to demonstrate that education for gender equality is not only a social principle but also a key factor in the sustainable modernization of rural communities.

Gender Education – A Foundation for the Modernization and Sustainable Development of Rural Areas

In the context of contemporary socio-economic transformations, the modernization of rural areas implies more than infrastructural development or economic growth; it involves a profound change in mindsets, social relations, and mechanisms of community participation. Within this framework, gender education emerges as an essential strategic tool, capable of generating sustainable structural changes and contributing to the full valorization of human potential in rural communities.

A first relevant aspect is the economic empowerment of women, which represents a key determinant of local development. In many rural communities, women still face limited access to economic resources, employment opportunities, and decision-making processes. Training programs in social entrepreneurship, leadership, and project management, implemented including by organizations such as the Center for Women's Development, contribute to building the skills necessary for initiating and managing their own businesses. This dynamic not only increases women's financial independence but also generates multiplier effects at the community level, through job creation, diversification of economic activities, and increased household resilience.

At the same time, gender education plays a crucial role in dismantling stereotypes and restrictive social norms. In rural areas, these stereotypes are often deeply rooted and influence both the educational pathways and professional choices of girls and women. Integrating gender education into school curricula and community initiatives contributes to shaping a new generation more aware of the principles of equality and equity. By promoting alternative role models and encouraging critical thinking, the foundations are created for overcoming limitations imposed by rigid traditions and for developing a more inclusive social climate.

Another essential pillar is the involvement of men in promoting gender equality. Modern approaches in this field recognize that real change cannot occur without the active participation of men. Encouraging their involvement in domestic responsibilities and childcare contributes to a more equitable redistribution of unpaid work and to reducing the phenomenon known as the "double burden" of women. Moreover, men's involvement fosters the development of relationships based on mutual respect, cooperation, and partnership—key elements for social cohesion.

Furthermore, integrating the gender perspective into local decision-making processes, through the application of the gender mainstreaming principle, represents a fundamental condition for inclusive and effective governance. Local public policies that fail to consider differences in needs and experiences between women and men risk perpetuating existing inequalities. Therefore, incorporating this perspective into policy planning and implementation ensures a more equitable distribution of resources and a better adaptation of interventions to community realities.

In conclusion, gender education should not be perceived as a secondary element of rural development, but as a central pillar of it. Through its impact on the local economy, the transformation of mindsets, and the strengthening of democratic participation, it contributes to building modern, resilient, and equitable rural communities. Thus, promoting gender education becomes not only a social necessity but also an essential strategy for long-term sustainable development.

Gender Equality – A Driver of Rural Economic Development

Gender equality represents an essential factor in stimulating rural economic development, having a direct impact on productivity, innovation, and sustainability. Harnessing the economic potential of women is no longer only a matter of social equity, but a strategic necessity for strengthening local economies and ensuring sustainable development.

In this context, the active involvement of women in the rural economy contributes significantly to increased productivity and the diversification of economic activities. Women bring different perspectives to resource management and activity organization, which fosters the emergence of innovative solutions adapted to community needs. At the same time, their economic participation reduces household dependence on a single income source and contributes to family financial stability.[2]

A key area in this regard is rural entrepreneurship, where the economic empowerment of women plays a decisive role. Through access to training, mentoring, and financial resources, including programs developed by the United Nations Development Programme, rural women are encouraged to initiate and develop their own businesses. These initiatives not only generate income but also contribute to the modernization of the agricultural sector, the development of local services, and the creation of new jobs. In addition, women's entrepreneurship stimulates the local economy through the reinvestment of income within the community.

Women also play a central role in promoting sustainable agriculture. Their involvement in agricultural activities is often oriented toward efficient resource use, environmental protection, and the adoption of ecological practices. In many rural communities, women are among the first to adopt innovative solutions, such as the use of renewable energy sources or environmentally friendly farming techniques. These practices contribute not only to ecosystem protection but also to improving agricultural production quality.[3]

Another strong argument in favor of gender equality is related to increased agricultural output. International studies show that ensuring equal access for women to essential resources—such as land, modern technologies, education, and financing—could lead to an increase in food production by up to 20%. This growth would have major implications not only for food security but also for poverty reduction in rural areas.

Gender equality should be viewed as a catalyst for rural economic development. By fully integrating women into economic activities and removing structural barriers that limit their access to resources, rural communities can become more prosperous, innovative, and resilient. Thus, promoting gender

equality is not only a measure of social justice but also a strategic investment in the future of the rural economy.

Education for Gender Equality through Community Initiatives: A Foundation for Rural Modernization

Education for gender equality represents one of the most effective tools of social transformation in rural areas, contributing not only to the promotion of fundamental rights but also to the deep modernization of communities. Beyond the formal framework of institutional education, this form of learning is increasingly expressed through community-based initiatives, which facilitate the transformation of mindsets, the development of social skills, and the consolidation of a culture of respect and inclusion.

Despite the progress made in the field of gender equality, rural areas of the Republic of Moldova continue to be marked by significant structural inequalities. One of the most evident aspects is the gender gap in access to education and the labour market, with women in rural areas having more limited access to higher education compared to those in urban areas, as well as lower rates of formal employment. This situation restricts professional development opportunities and contributes to the perpetuation of economic dependency.

At the same time, there is an unequal distribution of unpaid domestic responsibilities, most of which fall on women. Data show that a significant percentage of couples indicate that women perform the majority of household work, which reduces the time available for education, employment, or civic engagement.

In addition to these challenges, rural women also face increased vulnerability to climate change, caused by limited access to economic and technological resources. This vulnerability directly affects their capacity for adaptation and resilience, particularly in agriculture-dependent communities. Overall, these barriers highlight the need for integrated interventions, in which education for gender equality plays a central role in reducing disparities and supporting the sustainable development of rural communities.

In the Republic of Moldova, such initiatives have demonstrated that education for gender equality can be effectively integrated into community life, becoming a catalyst for local development. A relevant example is represented by projects implemented in 2025 by ten women-led organizations, with the support of UNFPA Moldova and coordination of Gender-Center. These interventions were designed not only as a response to gender-based violence, but as complex educational processes aimed at changing behaviours and social norms.

Through activities such as "Know Your Rights" information sessions, thematic workshops, intergenerational dialogues, and forum theatre, participants were engaged in an active learning process. These participatory methods facilitated the understanding of concepts such as equality, rights, and responsibilities, contributing to the development of critical thinking and the internalization of democratic values. Education was not limited to information transfer, but aimed at transforming attitudes and behaviours, which is an essential condition for sustainable social change.

An innovative element of these initiatives is the involvement of men and young people in educational processes. By including them as allies in promoting gender equality, the programmes contributed to redefining traditional roles and reducing gender stereotypes. This inclusive approach is essential for rural modernization, as change cannot be sustainable without the participation of all members of society.

The educational dimension of the initiatives was complemented by psychological, legal, and social counselling services, which can be understood as applied learning processes. Beneficiaries not only received support but also acquired skills in risk management, decision-making, and asserting their rights. These competencies directly contribute to increased personal autonomy and active participation in the economic and social life of the community.

The expansion of these interventions across 42 localities, including Cahul, Soroca, Ungheni, and Bălți, allowed the adaptation of educational methods to diverse socio-cultural contexts. This flexibility demonstrated that gender equality education can be effective when contextualized and rooted in local realities. At the same time, the impact on more than 2,000 beneficiaries highlights the capacity of these programmes to generate large-scale change.

The geographical distribution of the analysed initiatives is illustrated in Figure 1, which highlights the expansion of interventions across 42 localities in the Republic of Moldova. The map reflects the inclusive and decentralized nature of the programme, demonstrating that gender equality education was promoted not only in urban centres but also in diverse rural communities with different socio-cultural specificities.[5]



Figure 1. Geographical distribution of community-based initiatives for the prevention of GBV

Source: Gender-Center (2025) <https://gender-centru.md/zece-organizatii-conduse-de-femei-au-implementat-initiative-comunitare-pentru-prevenirea-violentei-bazate-pe-gen-in-42-de-localitati-din-republica-moldova/>

Another important aspect is the role of education in strengthening social cohesion. Community activities have created spaces for dialogue and collaboration, where community members were able to openly discuss sensitive issues and build relationships based on trust and mutual respect. These processes contribute to the formation of strong social capital, essential for sustainable development and for the ability of communities to cope with future challenges.

From a socio-economic perspective, education for gender equality has direct implications for rural development. By reducing violence and discrimination, it facilitates women's participation in economic activities, stimulates entrepreneurship, and contributes to the more efficient use of human resources. Thus, education becomes not only an instrument of social empowerment but also a determining factor of economic growth and modernization.

The results of the ten projects confirm that investments in women's leadership, inclusion, and community support have a direct effect on reducing violence and strengthening a culture of equality. Women have become more confident, better informed, and more empowered to claim their rights, while communities have become more united and more responsive toward individuals affected by violence.

In conclusion, the analysed community initiatives demonstrate that education for gender equality, when implemented through participatory methods and adapted to the local context, can generate profound transformations in rural areas. It contributes to the formation of more equitable, inclusive, and resilient communities, strengthening the foundations of sustainable development. Therefore, investment in gender education should be considered a strategic priority for the modernization of rural communities in the Republic of Moldova.

Conclusions and Recommendations

Based on the analysis conducted, it can be concluded that education for gender equality represents a fundamental element in the process of modernizing rural communities in the Republic of Moldova, having a direct impact on social, economic, and cultural development. It contributes to the restructuring of traditional social relations and promotes a development model based on equity, inclusion, and equal participation.

The results of the analysis highlight that rural areas continue to be affected by persistent structural inequalities, manifested through limited access of women to higher education, reduced participation in the formal labour market, and an unequal distribution of domestic responsibilities. These imbalances do not only affect the individual status of women but also directly influence the ability of communities to develop in a sustainable and competitive manner.

At the same time, it has been found that gender education and economic empowerment initiatives play a decisive role in reducing these disparities. Women who benefit from training, access to resources, and institutional support become active actors in the rural economy, contributing to the diversification of economic activities, increased household incomes, and strengthened community resilience.

Moreover, the involvement of men in promoting gender equality represents an essential factor in changing social norms. The redistribution of family responsibilities and increased awareness of gender roles lead to more balanced relationships and a reduction of social pressure on women. Last but not least, community projects aimed at preventing gender-based violence demonstrate that locally implemented interventions, adapted to specific contexts, can produce real changes in attitudes and behaviours. These initiatives contribute to increased awareness, the development of support mechanisms, and the creation of safer and more inclusive communities.

Based on the formulated conclusions, the following directions of action are proposed to strengthen the process of modernizing rural communities through the lens of gender equality:

1. **Systematic integration of gender education into educational and community policies**
It is necessary to consistently introduce gender equality topics into school curricula, as well as to develop non-formal education programmes in rural communities. This approach would contribute to forming a more informed, open, and aware generation regarding the importance of social equity.
2. **Strengthening mechanisms for women's economic empowerment**
It is recommended to expand training programmes in entrepreneurship, management, and digital skills, as well as to facilitate women's access to financing and productive resources. Support provided by institutions and organizations such as the United Nations Development Programme should be further utilized and extended at the local level.
3. **Promoting the active involvement of men in the gender equality process**
It is important to develop awareness and information campaigns that encourage men's participation in family and community life, contributing to the reduction of stereotypes and the balancing of social roles.
4. **Coherent implementation of gender mainstreaming policies**
Local authorities must integrate the gender perspective into all stages of the decision-making process, from planning to implementation, ensuring that public policies respond fairly to the needs of all community members.
5. **Development and expansion of community-based projects for the prevention of gender-based violence**
It is essential to support local initiatives aimed at preventing violence, creating support networks, and providing specialized services for vulnerable groups, with a focus on interventions adapted to the specific context of each community.

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A THEORETICAL SYNTHESIS OF THE CONCEPT OF FAMILY SOCIAL CAPITAL WITHIN THE FRAMEWORK OF RESEARCH INTO BUSINESS SUSTAINABILITY IN A TRANSITIONAL ECONOMY

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Abstract: *This paper offers a theoretical synthesis explaining why family firms in institutionally fragile environments often prove resilient - a pattern that contradicts standard economic theory, where the family is typically treated as a source of inefficiency. The objective is to build an integrative model of strategic decision-making that brings together the concept of Family Social Capital (FSC), insights from behavioural economics, and the new institutionalist framework. From this, a "socio-cognitive filter" model is proposed, showing that FSC is inherently ambivalent. In settings where formal institutions are weak - as the case of Moldova illustrates - FSC can act as a substitute for missing market mechanisms and reduce transaction costs. At the same time, it can lock inefficient practices in place, driven by loss aversion and the tendency toward system closure. The novelty lies in shifting away from a linear reading of FSC as purely a positive resource toward understanding it as a structural filter.*

Key words: *family social capital (FSC), socio-cognitive filter, new institutionalism, family business resilience, institutional ambivalence*

JEL: L26, D91, B52, P30

Introduction

Family business is the most common form of economic activity worldwide and play a crucial role in economic development. According to the EY/University of St. Gallen Global Family Business Index (2023), family firms generate more than half of global GDP, provide over 65% of jobs, and the combined revenue of the 500 largest family companies is comparable to the GDP of developing countries [1]. In the Republic of Moldova, small and medium-sized enterprises account for 99.2% of all enterprises, the majority of which are family businesses but lack official legal status [2].

However, standard economic theory, which assumes the rationality of economic agents and views the family as the sole decision-making mechanism, predicts an "outdated" and inefficient form based on kinship rather than professionalism [3]. Empirical data, in contrast, show high adaptability and stability of family businesses during crises [4]. This paradox requires a theoretical explanation that differs radically from the standard model.

The aim of this study is to build a model explaining how family social capital (FSC) influences strategic decisions and business sustainability. The model integrates FSC theory [5], behavioral economics [6], and the new institutional approach [7].

The proposed socio-cognitive filter model differs fundamentally from the dominant resource-based approach to family firms, particularly from the concept of "familiness" [8], by emphasising not simply the presence of family capital, but its reflexive use to overcome cognitive biases in weak institutional environments. It also complements the widely recognised socioemotional wealth (SEW) theory [9]. Whereas SEW focuses on the motivation of families - protecting non-financial assets (control, legacy) - our model explains the procedural mechanism: how exactly families make decisions under uncertainty, which cognitive filters they use, and under which institutional conditions family capital becomes productive

Theoretical analysis of family social capital

Social capital theory [10, 11] describes resources arising from social ties. For family business, the foundational framework is the Tagiuri-Davis "three-circle" model [12], showing the intersection of family, ownership, and business (Figure 1). Arregle et al. [5] define FSC through four characteristics: stability, intensity of interaction, interdependence, and system closure.

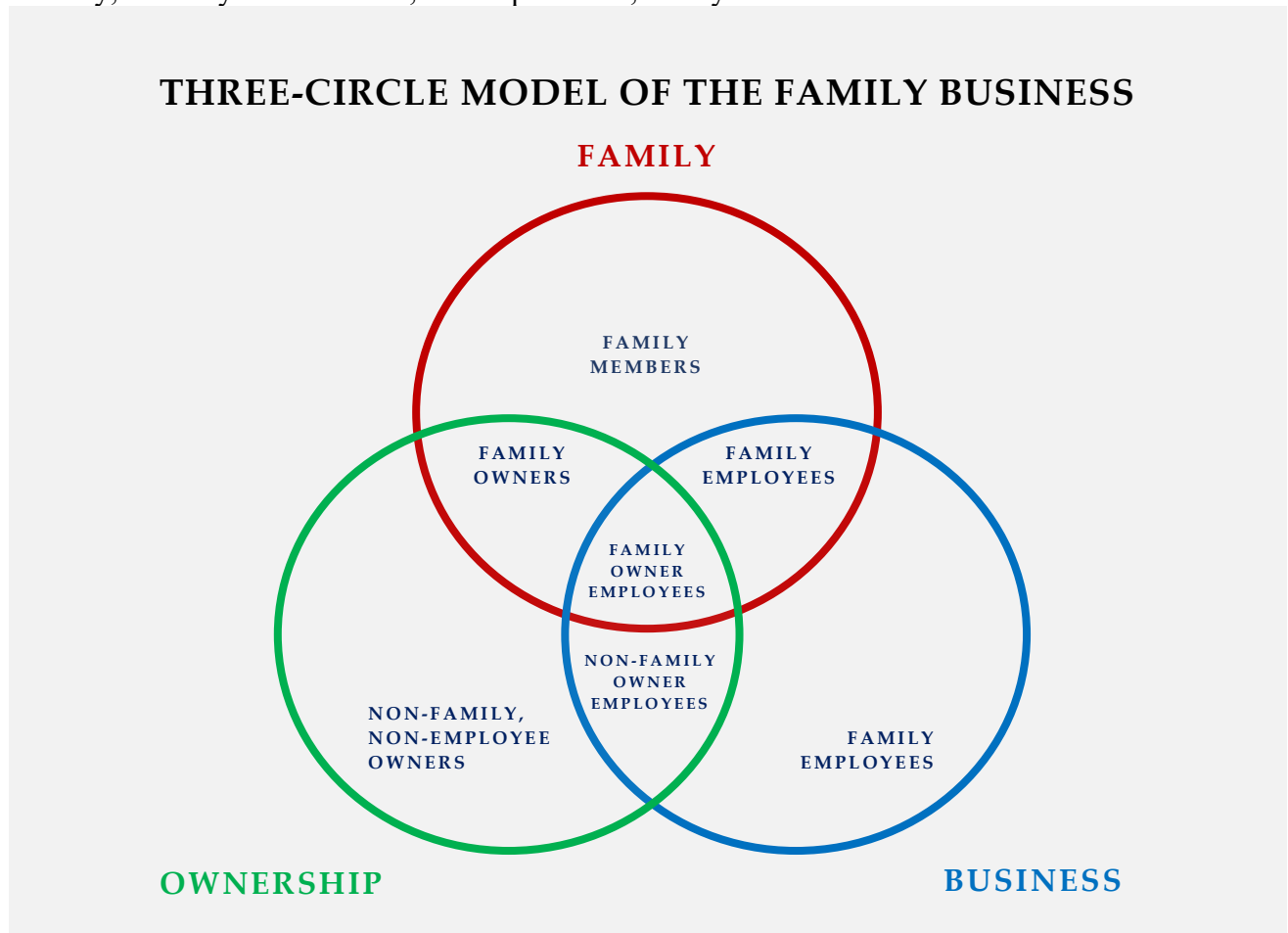


Figure 1. The Tagiuri-Davis "Three Circles" model

Source: <https://johndavis.com/> [12]

Unlike the model of rational choice, Simon [13] demonstrated that people have significantly limited cognitive resources and rely on heuristics. In the family business context, FSC does not eliminate biases but amplifies and collectivizes them. Table 1 summarizes three key biases.

According to North [7], formal institutions in transition economies are weak, which increases the value of informal (family) mechanisms. Moldova lacks a family business law [14], despite SMEs dominating the economy [2].

Table 1. Cognitive biases in family business decision-making

Cognitive bias	Mechanism	Typical institutional trap
Loss aversion	"Don't risk the inheritance"	Refusal of external financing, keeping firm small
Status quo bias	"We've always done it this way"	Retention of inefficient suppliers, technological backwardness
In-group favoritism	"Blood is thicker than water"	Appointment of relatives regardless of competence

Source: developed by the author based on Kahneman & Tversky [6] and institutional analysis of transition economies.

We define institutional reflexivity as the family's capacity for (a) cognitive awareness (recognising biases), (b) institutional monitoring (assessing how informal family norms interact with formal constraints), and (c) strategic flexibility (adjusting governance structures when tradition conflicts with business imperatives). Table 2 shows how FSC compensates for institutional weaknesses while also creating "traps".

Empirical indicators of high reflexivity include: higher education of family members, work experience outside the family firm, formal governance mechanisms (family council, independent directors), and documented succession planning based on competence.

Table 2. Institutional complementarity in Moldova

Institution	Role of FSC	Positive effect	Trap
Judicial system	Replaces contracts with trust	Lower transaction costs	No protection in large conflicts
Banking system	Informal lending	Fast access to capital	Credit ceiling blocking growth
Absence of family business law	Self-organization	Governance flexibility	No access to state support or tax benefits
Corruption	Closure as protection	Reduced administrative pressure	Voluntary refusal to scale

Sources: National Bureau of Statistics [2], Stamov [14], and author's analysis.

For future empirical testing, reflexivity R may be measured as a simple additive scale: $R = \text{sum of indicators (0–4)}$, where each indicator is coded as 1 (present) or 0 (absent). A value of $R \geq 3$ may be considered high reflexivity (threshold R^*). In this conceptual work, we use a qualitative distinction: high R - presence of most of the four indicators.

Institutional quality I is measured using the World Bank's Worldwide Governance Indicators (WGI) [15]. The aggregate index is constructed as the average of six components (Voice and Accountability, Political Stability, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption), then normalized to the [0, 1] range. Higher I value correspond to better institutional quality. A more concrete example of an institutional mechanism affecting family business is the Protected Geographical Indication (IGP) system in winemaking. IGP sets formal production protocols and quality control requirements, thereby increasing institutional pressure I. As shown in another study [17], such external requirements can force small family enterprises to formalize their tacit knowledge - a key component of reflexivity R. On the other hand, the high costs and bureaucratic complexity of IGP can act as entry barriers, displacing less reflexive family firms. This example illustrates that institutions can both stimulate and suppress the development of family business.

The model is multi-level: FSC - family level, R - governance level, I - country level. An adaptive decision (adaptive or non-adaptive) depends on the combination of these three factors.

The functional relationship can be expressed in qualitative form:

$$\text{Adaptive decision} = f(\text{FSC}, \text{R}, \text{I}, \text{FSC} \times \text{R}, \text{FSC} \times \text{I})$$

where:

- FSC - level of family social capital (high / low),
- R - level of reflexivity (high / low),
- I - quality of formal institutions (high / low),
- $\text{FSC} \times \text{R}$ - interaction of FSC and reflexivity,
- $\text{FSC} \times \text{I}$ - interaction of FSC and institutional quality.

Logic of the model (what the interaction terms show):

The interaction term $\text{FSC} \times \text{R}$ captures the effect of FSC under high reflexivity. This effect is expected to be positive (complementarity): the higher the reflexivity, the more strongly FSC contributes to

adaptive decisions. In other words, family capital becomes a productive resource only when the family is capable of critical self-assessment and flexible use of its norms.

The interaction term $FSC \times I$ capture the effect of FSC under weak formal institutions. This effect is expected to be negative (substitution): the weaker the institutions, the more firms rely on FSC as a substitute for missing market mechanisms. In a strong institutional environment, the importance of family capital diminishes.

Propositions emerging from the model:

- P1 (reflexivity threshold). Family social capital (FSC) contributes to adaptive strategic decisions only in families that demonstrate a high level of institutional reflexivity R.
- P2 (institutional substitution). The contribution of FSC to adaptive decisions is stronger when the quality of formal institutions I is weaker.
- P3 (complementarity). The effect of FSC is amplified when reflexivity is high: the synergy of family capital and the ability to use it flexibly yields the greatest positive outcome.

Combining the three approaches yields the "socio cognitive filter" model (Figure 2). Business sustainability is defined as the firm's ability to maintain viability (profitability, employment, control) in the face of external shocks without destroying the family governance structure.

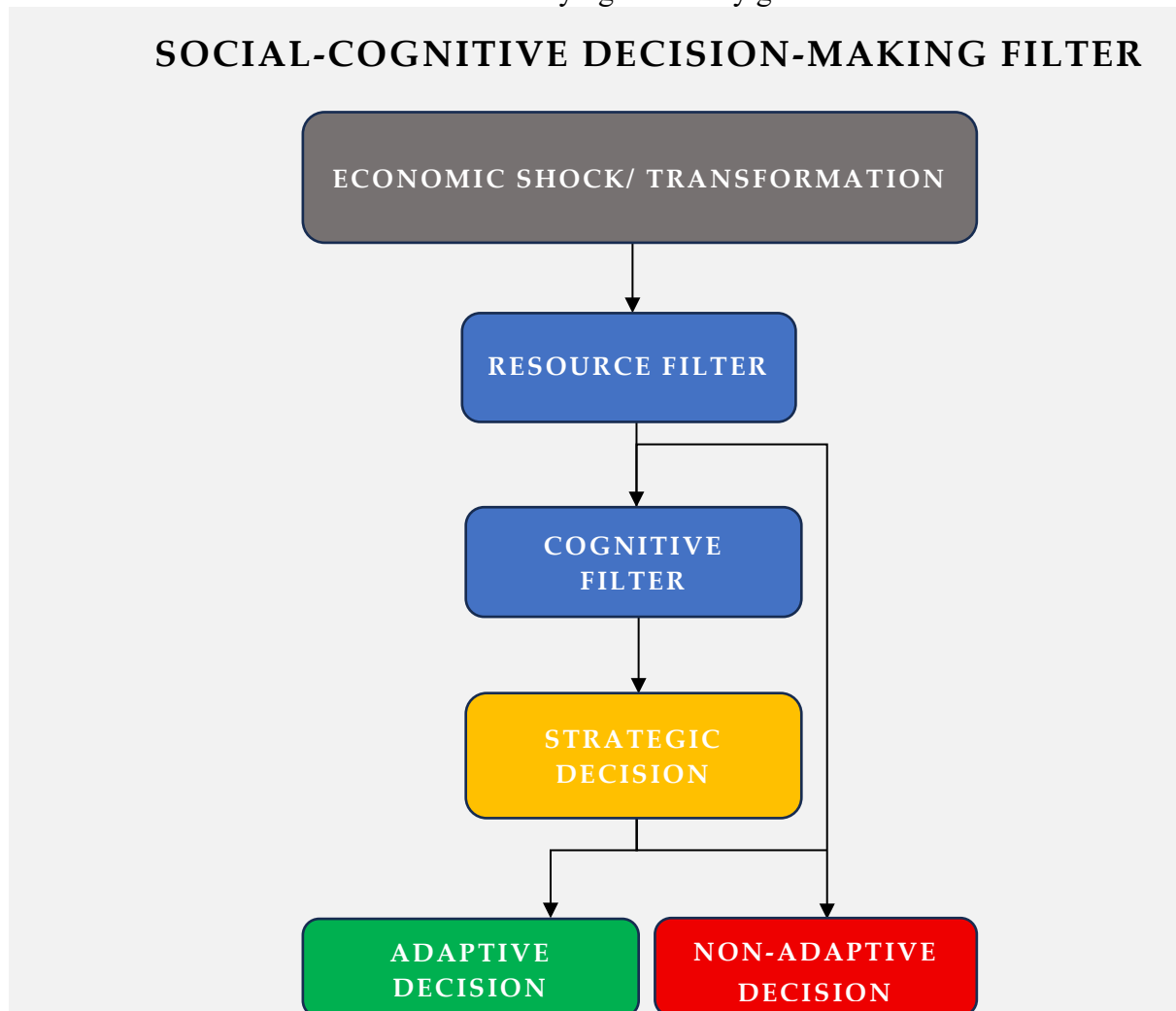


Figure 2. Theoretical model of the social-cognitive decision-making filter

Source: developed by the author

A striking example demonstrating the critical importance of flexibility in intra family norms is the real-life experience of the enterprise at the center of this study [4]. In an interview, one of the company's founders' states:

„My husband had foreseen this situation in advance and, upon retiring, proposed at a family council meeting that our younger son, Ivan, be appointed director of the company, since he had a degree in economics and sufficient work experience at the enterprise” [4, p. 62].

This quotation operationalizes the concept of reflexivity R in action: (a) cognitive awareness - the husband "had foreseen" the succession problem; (b) institutional monitoring - the family council served as a formal governance mechanism (one of the indicators); (c) strategic flexibility - appointment of the younger son over the elder, overriding seniority in favor of competence.

Thus, even in the absence of formal legal requirements, the family demonstrated high reflexivity, allowing it to avoid the "institutional trap" of nepotism. However, the success of this illustrative case may also be explained by alternative factors: low industry competition in the 1990s, the founder's personal informal networks (rather than FSC alone), favorable timing, and endogeneity (successful families accumulate FSC because of their success - selection bias). Recognizing these alternatives does not weaken the model - it reflects the methodological honesty required for scientific rigor.

Conclusion

The sustainability of a family business is not an automatic consequence of the family's existence. The socio-cognitive filter model reveals the ambivalent nature of FSC. In weak institutional environments, it reduces costs but can also create "rigidity traps". The key moderating variable is reflexivity R - the family's ability to critically evaluate its own norms and cognitive biases.

This work is exclusively theoretical. The proposed model requires empirical validation. The empirical illustration is a single case study, which does not permit statistical generalizations. Future research should: test the framework using qualitative comparative analysis (QCA) on a sample of family firms, operationalize reflexivity through surveys, and compare Moldova with other post-Soviet countries. Supporting family businesses in transition economies requires more than legal recognition. It requires programs that foster reflexivity: professional management training, subsidies for introducing independent directors, and requiring documented succession planning for access to public funding.

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MUNICIPAL GREEN BONDS AND ENERGY PERFORMANCE CONTRACTS AS DRIVERS OF PUBLIC-PRIVATE PARTNERSHIP IN THE RENOVATION OF PUBLIC BUILDINGS IN THE REPUBLIC OF MOLDOVA

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Abstract: *This study examines the integration of two innovative financial instruments — Municipal Green Bonds (MGB) and Energy Performance Contracts (EPC) implemented through Energy Service Companies (ESCO) — as drivers of sustainable Public-Private Partnership (PPP) in the renovation of public buildings in the Republic of Moldova. The aim of the research is to substantiate an integrated MGB-ESCO model capable of mobilizing private institutional capital for an estimated investment gap of 9.1 billion euros. The study adopts a qualitative methodology combining literature review (2018-2025), document analysis of EU and national legal frameworks, and case-study analysis of recent Moldovan projects — the Moldova Energy Efficiency Project, the Energy Vulnerability Reduction Fund, the Chişinău kindergarten modernization project, and the pioneering municipal bond issuances of Sîngera, Ceadâr-Lunga and Chişinău. Data sources include the National Bureau of Statistics, the World Bank, the European Commission and the Energy Community Secretariat. The findings demonstrate that, individually, ESCO contracts and Green Bonds face structural barriers — high cost of commercial capital and the shortage of bankable green projects with verifiable savings. Their integration within a blended finance architecture, however, generates a self-reinforcing renovation cycle in which municipalities act as financial aggregators, ESCOs absorb the technical risk, and institutional investors gain access to verified green assets. On this basis, four strategic recommendations are formulated for Moldovan public authorities.*

Keywords: *municipal green bonds, energy performance contracts, public-private partnership, blended finance, Republic of Moldova.*

JEL: G18, H54, Q56, R51.

Introduction

Ensuring a high level of energy efficiency of the national economy constitutes a fundamental precondition for achieving the goals of full and cost-effective decarbonization, enhancing global competitiveness and guaranteeing long-term energy security. Empirical data of the European Union indicate that buildings account for approximately 36% of total final energy consumption and around 40% of all anthropogenic greenhouse gas emissions directly related to energy processes. Moreover, statistics for 2023 confirm that 52% of all natural gas consumed in the European Union was, directly or indirectly, used for air conditioning, heating and electricity supply of buildings (European Commission, 2025a). In response to these challenges, the revised EU Energy Efficiency Directive sets stringent targets: reducing final energy consumption to no more than 763 million tonnes of oil equivalent by 2030, which requires at least doubling the current building renovation rate (currently at a critically low level of about 1% per year), and transforming the existing stock into zero-emission buildings by 2050 (European Commission, 2025a).

For the Republic of Moldova, the global energy crisis of 2022–2025 — triggered by the geopolitical instability in the East European region and systemic disruptions in the supply of conventional hydrocarbons — has exposed the critical vulnerability of the Moldovan economy, historically dependent on imported energy resources (Kontogouri, 2025). Given that 60% of national energy

consumption is attributed to the construction sector, the large-scale thermal modernization of both the residential and the public building stock is transformed from a narrow sectoral environmental initiative into a first-order macroeconomic security priority (World Bank, 2025).

Current estimates of investment needs reveal a vast gap between required and available financial resources. According to preliminary calculations of the World Bank and the relevant ministries, presented in the draft Energy Strategy of the Republic of Moldova until 2050, the comprehensive renovation and rehabilitation of the national building stock alone require no less than 9.1 billion euros (World Bank, 2025). It is evident that covering such considerable investment needs exclusively from the state budget, municipal appropriations or direct donor grants is mathematically and economically impossible, especially against the background of the budget deficit and the need to preserve fiscal stability. As a result, there is a clear need to design and adapt innovative financial mechanisms able to mobilize private institutional capital for the implementation of infrastructure projects.

Within this framework, two of the most promising and scientifically substantiated instruments capable of acting as drivers of a sustainable Public-Private Partnership (PPP) in the field of building renovation can be identified: Energy Performance Contracts (EPC) implemented through Energy Service Companies (ESCO), and Municipal Green Bonds (MGB) (C40 Knowledge Hub, 2022). Energy Performance Contracts are examined as an instrument for overcoming technical barriers and for the distribution of project risk, whereas Green Bonds are analyzed in the context of capital markets transformation and the development of ESG investing (Environmental, Social and Governance). However, the practical experience of transition economies demonstrates that, taken separately, these mechanisms face fundamental obstacles: the ESCO market stagnates due to the high cost of commercial lending and the distrust of the public sector, while the issuance of Municipal Green Bonds is constrained by the shortage of bankable projects capable of generating verified savings and transparent reporting.

The aim of this paper is therefore to substantiate, on the basis of a qualitative analysis of academic literature, the EU and national regulatory frameworks, and the most recent Moldovan case studies (2021–2025), an integrated financial-engineering model in which Municipal Green Bonds and ESCO mechanisms operate in inseparable symbiosis, supported by a blended finance architecture.

Literature review

Energy Service Companies (ESCO) are highly specialized economic operators offering project-based financing whose key feature is the provision of comprehensive energy services, including energy audits, design, financing, construction and installation works, as well as subsequent operation and monitoring of the modernized facilities. The interaction between an ESCO and a beneficiary (in the present study — local public administrations owning public buildings) is governed by an Energy Performance Contract (EPC). The principal difference between an EPC and a traditional construction works contract lies in the fact that the ESCO assumes both the technical and the financial risks, guarantees a certain level of energy savings, and is remunerated exclusively on the basis of the verified savings on energy expenditure actually achieved (Zheng et al., 2025).

Recent academic studies demonstrate that the formation of equilibrium strategies in the EPC model depends on several factors:

- the overestimation of potential losses by the beneficiary acts as the main systemic obstacle to the diffusion of innovation;
- in the conditions of insufficient qualification, municipal officials tend to perceive long-term obligations to pay a share of saved costs as a form of disguised lending bearing high risks;
- a conflict of interest arises, since municipalities seek to minimize their financial burden by requiring maximum levels of energy savings under zero up-front investment, whereas ESCO companies are forced to incorporate a high risk margin given the instability of the regulatory framework and the cost of capital.

The analysis of these models also demonstrates that at the early stages of market formation the development of the ESCO industry depends almost entirely on state subsidies and financial support, since both parties to the transaction (the ESCO and the municipality) exhibit a low initial readiness for cooperation. Mechanisms of state coercion (fines for inefficient energy use or for exceeding carbon quotas) exert a pronounced influence on the adaptation of economic agents to the new regulatory environment in the phase of low market maturity, yet, as the market reaches a phase of relative maturity, the effectiveness of punitive sanctions decreases, giving way to purely economic motives. Consequently, in order to launch the energy service market, a powerful external financial catalyst is required, capable of minimizing start-up risks and of providing access to inexpensive long-term financing.

A fundamental obstacle for the operability of the EPC model is the cost and availability of capital. The energy performance contract presupposes that the ESCO finances the initial capital expenditure (window replacement, facade insulation, heat pump installation) using its own or borrowed funds, while the return on the investment is realized over a period of 7–15 years. In Moldova and the neighbouring countries (such as Ukraine), macroeconomic instability dictates prohibitive commercial lending rates. As studies of Eastern European markets demonstrate, the rates on short-term corporate credit have historically ranged between 20% and 30% (Panev et al., 2018). In addition, the high level of inflation (which peaked at over 30% in Moldova in 2022) and exchange rate risks (tariffs are approved in the national currency, whereas equipment is imported in euros) render long-term cash flow forecasting impossible for commercial banks. Under such discount rates, the Net Present Value (NPV) of any energy service project becomes negative.

A second barrier consists in the public procurement procedure. Municipalities are obliged to conduct tenders within a strictly regulated public procurement law, which has traditionally been oriented towards the “lowest price” criterion when purchasing specific goods or construction works. Furthermore, the conclusion of EPC contracts is impossible without a reliable baseline database of historical energy consumption. Until recently, Moldova lacked both a systemic database on the energy consumption of buildings and a measurement and verification system of savings, which created the ground for legal disputes between ESCOs and municipalities concerning the methodology for calculating saved resources.

In order to overcome the barriers described above, state institutions have launched a series of reforms. A fundamental shift was the adoption by the Parliament of the Republic of Moldova of Law No. 282 of 5 October 2023 “On the Energy Performance of Buildings”, which entered into full legal force in the spring of 2024 (Law No. 282/2023). This legal act lays a European foundation: Article 12 obliges the State to develop a long-term strategy for the renovation of the national real estate stock, while Article 13 regulates in detail the mechanisms of financial incentives and the overcoming of market barriers in order to attract private investment (Law No. 282/2023). A significant step has also been taken in the digitalization of the sector: with the financial support of the World Bank, within the M-GROW programme, the design and implementation of the National Information System for the Energy Performance of Buildings (NISEEB) has been initiated. This system, the tender for which was launched at the end of 2025, is to become the central analytical core, providing investors and ESCO companies with reliable data. In parallel, in order to address the problem of human resources shortage at the municipal level, in September 2024 the Energy Efficiency Training Network was officially launched in Chişinău with GIZ support, providing instruments of energy planning and access to professional networks (Stockholm Environment Institute, 2025).

The second component of the model investigated is constituted by Green Bonds. As fixed-income instruments, Green Bonds differ from classical debt securities exclusively through the targeted nature of the use of the funds raised — these must be channelled strictly towards the financing or refinancing of projects generating measurable environmental or climate benefits (C40 Knowledge Hub, 2022).

For a long period, subnational debt instruments were not used in Moldova. A breakthrough occurred in the period 2022–2024, owing to the technical assistance of donors and to the projects of Expert-Grup. The debut issuances of municipal bonds by the town halls of small cities — Sîngera and Ceadâr-Lunga — demonstrated an unexpectedly high appetite from local investors, both issuances being closed in advance due to oversubscription (Expert-Grup, n.d.). Shortly thereafter, the largest commercial bank of the country, MAIB, acted as arranger and underwriter for the primary issuance of municipal bonds of the capital city of Chişinău. In April 2024, with the support of the Embassy of the Netherlands, a long-term programme was launched to support four additional Municipal Public Administrations (MPAs) in the issuance of their own debt securities (Expert-Grup, n.d.). Although these first issuances did not undergo the complex certification procedure under the standards of the International Capital Market Association (ICMA) as strictly “green” (Green Bonds), they shaped the legal, procedural and cultural infrastructure for future targeted climate issuances.

For municipalities, the issuance of Municipal Green Bonds provides a number of strategic advantages over traditional bank borrowing. First, bonds generate economies through the aggregation of a portfolio of multiple local projects (for example, the renovation of dozens of kindergartens, hospitals and administrative buildings) into a single investment proposition attractive to large institutional investors (pension funds, insurance corporations). Second, the unmet demand from the private sector for sustainable investments often allows issuers to place bonds with the so-called “greenium” — a negative yield spread compared to conventional bonds of the same credit quality, which directly reduces the cost of capital for the municipality. Third, the access to public capital markets entails internal institutional changes within municipalities: transparency is enhanced, risk management procedures are improved and interdepartmental coordination between financial and environmental departments is strengthened.

Particular relevance, within the financing of public buildings, is acquired by the integration of Green Bonds with the Sustainable Development Goals (SDGs). The issuance of debt obligations directed at the modernization of social infrastructure (educational institutions, hospitals) allows combining environmental metrics (the reduction of CO₂ emissions) with socioeconomic indicators (improvement of the quality of the educational environment, reduction of respiratory diseases owing to proper ventilation, accessibility of services). Hence, the convergence of the ESCO model and the Green Bond model represents a synthesis between technical guarantee of result and long-term optimized financing.

Methodology and conceptual framework

The present study adopts a qualitative methodological approach combining several research techniques. First, a critical analysis was carried out of the recent academic literature (2018–2025) on ESCO and EPC mechanisms, Green Bonds, blended finance and energy efficiency policy in transition economies. Second, a document analysis was conducted of European Union directives, national legal frameworks (notably Law No. 282/2023 on the Energy Performance of Buildings) and key strategic documents, such as the draft Energy Strategy of the Republic of Moldova until 2050 and the National Energy and Climate Plan (NECP). Third, a case-study analysis was carried out of pilot and ongoing projects in Moldova: the Moldova Energy Efficiency Project (MEEP); the STEEM and M-GROW programmes; the Energy Vulnerability Reduction Fund (EVRF); the kindergarten modernization project of Chişinău, implemented under the Green City Action Plan of the European Bank for Reconstruction and Development (EBRD); and the pioneering municipal bond issuances of Sîngera, Ceadâr-Lunga and Chişinău. Finally, a comparative statistical analysis was performed using data from the National Bureau of Statistics of the Republic of Moldova, the World Bank, the European Commission and the Energy Community Secretariat.

The analytical framework of the study is built on three pillars. The first pillar refers to the macroeconomic context of the energy vulnerability of the Republic of Moldova and to the need to shift from consumption-side subsidies to capital investments in the infrastructure of the building

stock. The second pillar refers to the microeconomic logic of EPC contracts (the transfer of technical risk to the ESCO and performance-based remuneration). The third pillar refers to the financial logic of Municipal Green Bonds, viewed within a blended finance architecture (first-loss capital, credit enhancement and the mobilization of institutional investors). The integration of these three pillars makes it possible to formulate the proposed PPP model and the corresponding operational recommendations.

Results and discussions

Condition of the building stock and energy vulnerability of the Republic of Moldova

In order to objectively assess the potential for the implementation of an integrated financial model, an analysis of the current state of the national building stock and of the specific energy vulnerability of the Republic of Moldova in the period 2021–2025 is required. The statistical analysis based on the data of the National Bureau of Statistics of the Republic of Moldova shows that, as of 1 January 2024, the national housing stock comprised 1,331.3 thousand dwellings, representing a 0.5% increase compared with the previous year. The total floor area of the housing stock exceeded 91.15 million square metres (NBS Moldova, 2024). Although these figures describe the residential segment, they reflect the general degree of obsolescence and the scale of the construction infrastructure requiring intervention. This level of inefficiency generates an overload both for the national energy grid — dependent on the unstable import of natural gas and electricity (including the critical dependence on the Moldavian GRES located in the Transnistrian region and on the transit routes through Ukraine) — and for the fiscal system of the municipalities (European Commission, 2025b). With a view to radically changing the development vector, in 2023–2024 the Government of the Republic of Moldova updated the strategic national documents. The adopted National Energy and Climate Plan (NECP) provides for the achievement, by 2030, of a 27% share of renewable energy sources (RES) in final energy consumption and 30% in the structure of electricity production. Furthermore, in the framework of the national legislation, the EU directive optimizing the regulation of RES auctions and establishing sustainability criteria has been transposed (Energy Community Secretariat, 2025). Nevertheless, the achievement of these targets is impossible without a parallel reduction of baseline demand through energy efficiency programmes.

Energy poverty and the transformational effects of the EVRF and of the national renovation programmes (MEEP and STEEM)

The critically low energy efficiency of the infrastructure, combined with the inflationary shocks of 2022 (when European spot gas prices set historical records), provoked a large-scale energy poverty crisis in the Republic of Moldova. The reaction of the State took the form of the creation of the Energy Vulnerability Reduction Fund (EVRF), supported by the United Nations Development Programme, the governments of Italy, Slovakia and other partners (UNDP Moldova, 2025). This Fund implemented a complex information system (EVIS) distributing targeted financial compensations on citizens' utility bills, depending on their verified income level and energy consumption.

The analysis of empirical data for the cold seasons of 2022–2023 and 2023–2024 demonstrates that the State interventions have protected the population from a massive transition into a state of critical energy poverty. Without these payments, the level of energy poverty would have exceeded 89.0%, however, owing to the EVRF, it was reduced to 81.3%. The absolute monetary poverty rate decreased from an estimated 44.3% to 34.9%, while food poverty fell from 25.6% to 17.8%. The assistance proved particularly critical for vulnerable demographic groups: female-headed households, the elderly and Ukrainian refugees (among the latter, the rate of monetary poverty declined by 18 percentage points) (UNDP Moldova, 2025).

Despite the social success of the programme, the academic expert community and international donors unanimously recognise that the subsidization of tariffs (the compensation of operating expenditure) is a fiscally unsustainable path. The long-term strategy of the National Center for Sustainable Energy (NCSE) and the Ministry of Energy requires a transition from the subsidization

of consumption to the subsidization of capital investment in energy efficiency. The first step in this direction was the "EcoVoucher" programme, launched at the end of 2023, in the framework of which vulnerable families received targeted funds to replace old household appliances. As a result of the use of 39,084 vouchers, an annual saving of 1.6 million kWh (approximately 7 million Moldovan lei) and a corresponding reduction in carbon dioxide emissions were achieved (Berzerdeanu et al., 2025).

At the national level, the principal project is the Moldova Energy Efficiency Project (MEEP), with a total budget exceeding 70 million euros. The financing of the project is based on parity co-financing: the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) have provided sovereign loans of 30 million euros each, which are complemented by a grant from the EU Neighbourhood Investment Platform (NIP Grant) of approximately 12–15 million euros. Phase I of the project focused on the reconstruction of republican hospitals, whereas Phase II (launched in August 2023) shifted the emphasis to institutions under local authority (schools, kindergartens, district medical units). The implementation of MEEP allows the operationalization of standardized environmental and social assessment procedures, stakeholder engagement plans and public procurement procedures aligned with EU standards (MEPIU, 2022).

In parallel, within the M-GROW mechanism and the STEEM (Sustainable Transition through Energy Efficiency in Moldova) project, detailed energy audits of 46 public schools have been financed (covering more than 46,000 pupils), which represents an absolutely necessary stage for the preparation of design and estimate documentation and for the formation of investment projects eligible for future Green Bond issuances (World Bank, 2025).

The Chişinău kindergarten modernization project as a symbiosis of municipal debt and ESCO mechanisms

The most representative project, demonstrating the evolution of financing and the elements of the future symbiosis with ESCO, is the project for enhancing the energy efficiency of kindergartens in Chişinău, initiated in 2024. This project is organically integrated into the Green City Action Plan for Chişinău, implemented under the aegis of the EBRD (Chişinău Municipality, 2019). The project covers the deep thermomodernization of up to 30 preschool institutions. The technical package includes the insulation of the building envelope, the modernization of heating and water supply systems, the replacement of joinery, the installation of air recovery systems and the deployment of distributed renewable energy sources (photovoltaic panels and solar collectors). The expected engineering outcome is energy savings of 55% (over 46,000 GJ per year) and an annual reduction of greenhouse gas emissions of 3,165 tonnes of CO₂ equivalent (EBRD, 2026). The financial structure of this project is a classic example of blended finance, combining IFI credit resources, grants and contribution from the municipality itself.

However, the most fundamental aspect of this project is its institutional dimension: the project provides not only for physical works, but also for the introduction of energy management standards, mandatory energy audits, and the introduction of Energy Performance Contracts (EBRD, 2026). This is direct evidence that international development institutions purposefully use large tranches of municipal debt for the development of the ESCO market, stimulating the engagement of private engineering firms in the implementation of municipal tasks.

The proposed integrated MGB–ESCO model

The analysis of theoretical barriers and the examination of practical projects (MEEP and the Chişinău kindergarten project) allow scientifically substantiating an innovative financial-engineering model of PPP, in which Municipal Green Bonds and ESCO mechanisms operate in inseparable symbiosis. This integration solves the main problems: it minimizes the "erroneous overestimation of potential losses" by the clients and it addresses the inaccessibility of cheap capital for the contractors. In the proposed model, the municipality does not merely act as a beneficiary but is transformed into a financial aggregator, which is fully consistent with the new public management approach.

The operational sequence is as follows. First, the municipality conducts standardized energy audits of hundreds of public buildings (schools, kindergartens, polyclinics), thus shaping a large-scale verified investment portfolio (green portfolio). Against this portfolio, the municipality issues Municipal Green Bonds on the domestic or international capital markets. Owing to the use of the municipal credit rating and the guarantees attached to the issuance, the coupon rate on these bonds is expected to remain in the single-digit range, which is significantly cheaper than commercial loans at 20–30% applicable to private contractors. The capital raised from institutional investors (including the international financial institutions themselves, local banks and pension funds) is accumulated in a dedicated Municipal Fund, the management of which involves external auditors.

Subsequently, the transfer of technical risk occurs: instead of independently procuring equipment and contracting dozens of construction crews, the municipality launches tenders for the conclusion of EPC contracts. ESCO companies win the tenders, guaranteeing a specific percentage of energy consumption reduction (for example, 55%, as in Chişinău). The financing of capital expenditure is provided to the ESCO from the Municipal Fund in the form of targeted interest-free or low-interest loans (or the municipality pays directly, but the contract obliges the ESCO to refund the investment in the event of non-achievement of the KPIs). In return, the municipality is relieved of technical risks: should the heat pumps malfunction or the insulation prove inadequate, the ESCO will not receive a performance premium and will be obliged to compensate the difference under the contract.

Once the modernization is completed, the municipal expenditure on heating and electricity bills drops sharply. The difference between the baseline (historical) energy budget and the new (low) bills constitutes a free cash flow stream. This saved amount is annually redistributed: a portion is used for the payment of coupons to the holders of the Green Bonds and for the gradual formation of a sinking fund for the principal; a portion is paid to the ESCO as a premium for guaranteed performance; and the remainder forms a net profit of the local budget, which can be channelled to social needs or reinvested in the Fund to finance new projects.

In order for the green bonds of Moldovan municipalities to inspire confidence among international and local investors, the model requires the application of the concept of blended finance. As studies of emerging market economies show, blended finance entails the strategic use of a limited amount of public or grant capital in order to mobilize large-scale private investment. Within the context of the Republic of Moldova, such concessional capital can take the form of grant funds from the European Union (e.g. NIP grants), tranches from Norway via the M-GROW Fund, or resources from the Global Environment Facility (GEF). These non-repayable resources should be used for the formation of a first-loss tranche covering potential defaults on municipal bonds. If the municipality, for force majeure reasons, fails to honour a coupon payment, investors are compensated from this grant-based guarantee fund. The presence of such a layer instantly raises the credit rating of the issuance, reduces the interest rate, and makes investments in Moldovan energy efficiency attractive to global ESG funds. The complementarity is evident: Green Bonds provide liquidity at a low cost, the blended finance arrangement reduces financial risks for investors, and EPC contracts fully insure the municipality against technical and operational failures.

Conclusions

The renovation of the outdated public building stock of the Republic of Moldova constitutes one of the most complex infrastructure challenges of the current decade. In conditions in which the average energy consumption of public buildings is nearly twice the European Union standards, and where considerable thermal losses impose a heavy inflationary burden on the budget and on society, the transition from fiscally burdensome consumption subsidies to investments in infrastructure capital represents the only sustainable macroeconomic strategy.

The conducted research demonstrates that the integration of the instruments of Municipal Green Bonds and Energy Performance Contracts (implemented through ESCOs) forms a powerful

foundation for Public-Private Partnership. Municipal Green Bonds act as the financial foundation: they consolidate fragmented projects, eliminate the problem of high banking rates, and open access to the global liquidity of ESG funds prepared to invest in climate objectives. In turn, EPC contracts, implemented by qualified energy service companies, ensure the engineering integrity of the process: they neutralize the technical and operational risks for the municipalities, guaranteeing that investments are actually converted into saved gigajoules and reduced CO₂ emissions.

The analysis of the practice of 2021–2025 testifies to a high degree of institutional readiness of Moldova for this transformation. The successful issuance of municipal bonds in the regions, the systemic integration of blended finance elements into projects (the modernization of dozens of kindergartens in Chişinău with the participation of the EBRD and the EIB for over 30 million euros), as well as the large-scale legal adaptation (Law No. 282 of 5 October 2023 "On the Energy Performance of Buildings") have created a robust basis for further development. The synchronization of these instruments, supported by blended finance guarantee mechanisms, is capable of launching a self-reproducing renovation spiral, strengthening the energy security of the country, stimulating the growth of the local green business and ensuring the full-scale integration of the Republic of Moldova into the European climate system.

Based on the results of the study, a set of strategic recommendations may be formulated for the state structures of the Republic of Moldova (the Ministry of Energy, the Ministry of Finance, the National Commission for Financial Markets and the National Center for Sustainable Energy):

1. Legislative legitimation and standardization of EPC contracts. It is necessary to develop and approve, at the level of a Government Decision, unified standard forms of energy performance contracts, in line with the Law on Public-Private Partnerships and the Law on Public Procurement. It is essential to legally enshrine the priority of the life-cycle cost assessment method over the lowest-price criterion in procurement for energy efficiency projects — this will ensure legal predictability for potential ESCO investors.

2. Creation of a guarantee mechanism. Drawing on the resources of the Energy Efficiency Fund and on the donor support of M-GROW, the State should establish a National Guarantee Scheme, providing bank-level sureties for small and medium-sized ESCO companies during their start-up phase.

3. Institutionalization of Municipal Green Bonds and taxonomy alignment. The National Commission for Financial Markets should develop methodological guidelines for local public authorities on the issuance of environmentally labelled securities aligned with the European green taxonomy and with the standards of the International Capital Market Association (ICMA).

4. Development of human capital and of knowledge transfer networks. The scaling-up of initiatives such as the Energy Efficiency Training Network for municipal managers and the "Women in Energy Internship" programme is essential to consolidate the institutional readiness for hybrid financial-engineering instruments.

Limitations and future research directions.

The present research has several limitations that need to be acknowledged. First, the model is substantiated on a qualitative basis, drawing on case-study evidence and document analysis; an econometric estimation of the precise coupon rate, of the optimal size of the first-loss tranche, and of the leverage ratio of grant capital to mobilized private capital is beyond the scope of this paper and constitutes a natural extension of the present work. Second, the empirical evidence available on Moldovan municipal bond issuances is still limited to a small number of pilot cases (Sîngera, Ceadâr-Lunga, Chişinău), which restricts the generalizability of the conclusions on investor appetite and on the magnitude of a potential greenium. Third, the analysis assumes a stable macroeconomic and political environment; severe shocks (geopolitical, fiscal or monetary) may significantly alter the parameters of the proposed architecture.

Future research directions could therefore proceed in three complementary directions: (i) the construction of an econometric model that quantifies the leverage effect of blended finance on the mobilization of private capital in transition economies; (ii) a comparative analysis of the applicability of the proposed MGB-ESCO architecture in countries with structural conditions similar to those of Moldova — notably Ukraine, Georgia and the Western Balkans; and (iii) the development of a dedicated measurement, reporting and verification framework for the social co-benefits of public-building renovation, allowing a more rigorous integration of environmental and socioeconomic indicators within the use-of-proceeds reporting of Municipal Green Bonds.

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THE IMPACT OF ARTIFICIAL INTELLIGENCE AND TECHNOLOGICAL TRANSFORMATIONS ON ECONOMIC PROCESSES

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Abstract: *This paper examines how the spread of artificial intelligence (AI) and related technological transformations influence economic processes. Although AI is hailed as a driver of productivity and innovation, empirical evidence so far shows limited near-term effects on aggregate productivity or employment. We review recent research and reports on AI adoption, productivity impacts, labor market outcomes, and industry changes. Using a qualitative literature review and synthesis of key findings, we show that AI investments have surged and can boost output in principle, but actual adoption remains concentrated in a few sectors. Labor-market effects have been modest to date: surveys find ~90% of firms reporting no employment or productivity impact from AI so far, and macro data show little change attributable to AI. On the other hand, AI is already enabling higher outputs in some tasks (e.g. code generation or R&D) and may increase total factor productivity if widely deployed. Conclusions highlight that AI's long-term effect depends on factors like worker skills, firm adaptation, and public policy. We discuss implications for economic growth, inequality, and future research, noting that careful policy will be needed to harness AI's benefits while managing disruptions. In addition, the paper highlights the implications of artificial intelligence for professional training and human resource development, particularly in the accounting field, emphasizing the need for new competencies and personalized learning approaches.*

Keywords: *Artificial Intelligence; Technological Change; Productivity; Labor Market; Innovation.*

JEL: O33; O34; J24; L86

Introduction

Artificial intelligence (AI) and related digital technologies are often described as ushering in a new industrial revolution capable of transforming how economies and organizations function. AI refers to software and systems capable of performing tasks that traditionally required human cognitive abilities, such as learning, perception, and decision-making. Its applications are rapidly expanding across multiple sectors, from manufacturing to services, including finance, accounting, and human resource management. Policymakers and analysts argue that AI has the potential to enhance efficiency, stimulate economic growth, and create new markets and industries. At the same time, concerns have been raised regarding its potential to disrupt labor markets, widen inequalities, and contribute to the emergence of dominant "super-firms."

In this context, organizations are increasingly required to adapt to technological change by rethinking their internal processes, particularly those related to professional training and human resource development. In knowledge-intensive domains such as accounting, technological transformations are redefining traditional practices and increasing the demand for new competencies and continuous learning. However, traditional approaches to professional training, often based on standardized content, are becoming insufficient to address the dynamic and individualized needs of employees.

The integration of artificial intelligence into training processes represents a promising solution to these challenges. AI enables the development of personalized learning pathways based on data analysis and real-time performance monitoring, allowing organizations to tailor training programs to individual needs. This shift contributes to more effective learning outcomes and has a direct impact on human resource development, leading to improved skill acquisition, increased employee engagement, and enhanced organizational performance.

At the same time, it is important to consider the gap between theoretical expectations and empirically observed outcomes of technological change. The historical "productivity paradox" illustrates how technological advancements do not always immediately translate into measurable productivity gains. Similarly, despite significant investment and widespread attention, recent evidence suggests that the impact of AI on productivity and employment remains uneven and, in some cases, limited. Surveys conducted in recent years indicate that many organizations have not yet experienced significant improvements in productivity or labor outcomes as a result of AI adoption. These observations highlight the need for a more nuanced understanding of how AI is effectively integrated into organizational processes.

The aim of this paper is to analyze the integration of artificial intelligence in professional training and to examine its impact on human resource development, with a particular focus on the accounting field. The research is based on a qualitative methodology, involving the analysis and synthesis of recent scientific literature, reports, and empirical studies related to AI adoption, training processes, and labor market transformations. By adopting a multidisciplinary perspective, the paper seeks to provide a comprehensive understanding of the role of artificial intelligence in supporting the development of human capital and proposes a conceptual framework that highlights the relationship between AI, training personalization, and the development of employee competencies

Methodology

This study employs a qualitative research approach based on a structured literature review. The aim is to analyze and synthesize recent findings regarding the integration of artificial intelligence into professional training processes and its impact on human resource development, particularly in the accounting field.

The research methodology is based on the analysis and synthesis of existing scientific literature on artificial intelligence, professional training, and human resource development. Special attention is given to the role of AI in transforming training processes and supporting the development of employee competencies in knowledge-intensive domains such as accounting.

The data used in this research consist of academic articles, institutional reports, and policy papers published between 2020 and 2026. The sources were selected from internationally recognized databases such as Web of Science and Scopus, as well as reports issued by international organizations, central banks, and consulting firms.

The selection criteria included: (i) relevance to artificial intelligence and its application in training and human resource development; (ii) publication in English; and (iii) focus on key dimensions such as technological adoption, skills development, labor market transformation, and organizational performance. Irrelevant or duplicate sources were excluded following a screening of titles, abstracts, and keywords.

The analysis follows a thematic synthesis approach, identifying and grouping key findings into major categories: the integration of AI in training processes, the personalization of learning, the impact on human resource development, and the implications for accounting-related activities. This method allows for a comprehensive and multidisciplinary understanding of the role of artificial intelligence in organizational contexts.

Although this approach provides a broad overview of current research, it is limited by the availability of recent empirical data and the rapid evolution of AI technologies. Therefore, the conclusions should be interpreted as indicative of current trends rather than definitive long-term outcomes.

Basic Content

Adoption and Sectoral Patterns

Investment in AI technologies has indeed grown rapidly. A McKinsey Global Institute report notes that worldwide investment in AI tripled in 2016 versus the prior year, and by 2017 was at a high rate. Venture capital and corporate R&D spending have poured tens of billions into AI development. However, adoption by incumbent firms has lagged: as of 2017, McKinsey observed that "adoption in 2017 remains low" despite high investment. AI deployment tends to be concentrated in highly digitalized sectors: large tech firms, financial services, and industrial manufacturing showed higher uptake of AI-based analytics and automation. Many traditional sectors – agriculture, construction, basic services – currently use little AI. Experts at Stanford's economic policy forum remark that "[AI's] adoption [in the workplace] is actually pretty low and it's very concentrated in tech, in professional services, and in finance. Lots of sectors are doing very little with AI". This uneven diffusion implies that any economic impact will be initially limited to certain segments.

Corporations are cautious. Surveys of executives reveal that most use AI sparingly; in one study only two-thirds of large-firm executives reported any AI usage, and typically only a few hours per week. Moreover, a 2026 Fortune/NBER study found that 90% of firms reported no change in productivity or employment from AI so far. In practice, many companies are still in pilot or "experimenter" mode. As one CEO commented, "The technology is not the hard part. It's the changing-the-company part that's hard". Thus, while investment budgets have expanded, the translation into broad adoption and process change remains gradual.

The process through which artificial intelligence influences economic outcomes is complex, gradual, and mediated by multiple interdependent factors. Although investments in AI technologies have increased significantly in recent years, their impact on macroeconomic indicators such as productivity and economic growth is neither immediate nor uniform across sectors. This discrepancy can be explained by the fact that AI-driven transformations require not only technological adoption, but also substantial organizational adjustments, workforce reskilling, and institutional support.

At the firm level, the integration of AI systems involves changes in business processes, decision-making structures, and operational strategies. These transformations generate productivity gains primarily at the task level, which are then gradually translated into improvements in firm performance. However, the aggregation of these micro-level effects into measurable macroeconomic outcomes depends on the speed of diffusion, the absorptive capacity of firms, and the broader economic environment.

Therefore, the relationship between AI investment and economic growth can be understood as a multi-stage transmission mechanism, characterized by a time lag between initial adoption and observable large-scale effects. This conceptual process is illustrated in Figure 1.

This perspective is consistent with the broader literature on general-purpose technologies, which emphasizes delayed but transformative economic effects.

Productivity and Economic Growth

If and when AI spreads, what might it do to productivity and growth? The theoretical consensus is that AI, as a general-purpose technology, can raise output per worker over time. For instance, a Congressional Budget Office analysis notes that by enabling businesses to provide goods and services differently, AI "could affect economic growth, employment and wages, and the distribution of income". Many economists project a moderate boost to productivity growth as AI matures. A Dallas Fed study suggests a plausible scenario is that AI raises U.S. productivity growth by ~0.3 percentage points per year over a decade. Goldman Sachs estimates global job exposure figures (25% of U.S. work hours) implying significant potential efficiency gains. BIS analysts note that micro-level studies find generative AI can improve productivity in specific tasks by 10–65%, especially in coding, writing, and consulting tasks. These gains tend to be larger for less experienced workers, suggesting a "democratization of expertise" within firms.

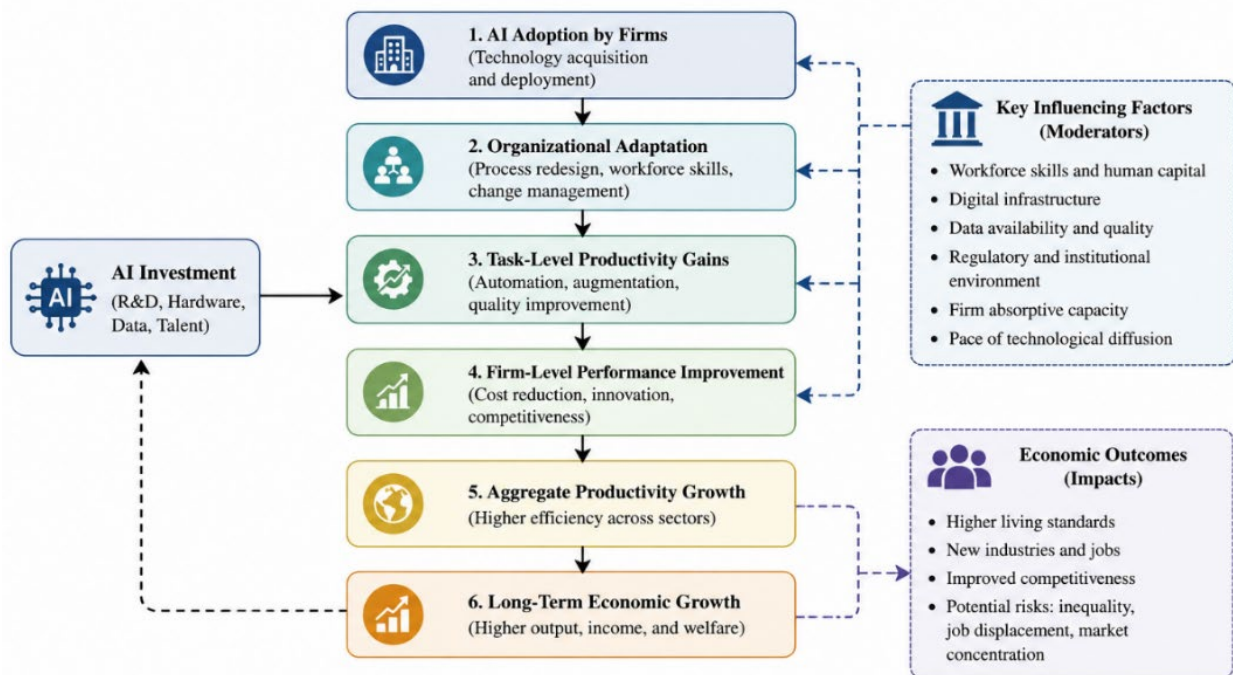


Figure 1. Conceptual framework of AI adoption and its impact on economic processes

Source: Author's conceptualization.

However, measured aggregate effects remain small so far. Recent data show no major jump in macro productivity. One report observed only a 0.5% projected productivity gain over the next decade due to AI in a best-case scenario. The Dallas Fed also notes that - even if AI delivers on optimistic forecasts - the implied increase in living standards by 2050 would be non-trivial but not earth-shattering. There are understandable lags: historically, revolutionary technologies took years or decades to affect GDP statistics. As one expert remarks, even the computer revolution of the late 20th century did not show up in data until the 1990s. Early analyses suggest we may be in the “early innings of a long game”.

It is also possible that AI’s impact will be uneven. Models of “task automation” predict that by 2030 a significant share of routine cognitive tasks could be automated. In the short run, AI’s productivity gains may be offset if displaced workers move to less-automatable activities (a Baumol effect). Some studies caution that if AI primarily augments high-skilled tasks, it could widen wage or sectoral gaps unless complemented by training and adaptation. On the positive side, if AI-driven innovation leads to new goods and services, it could boost demand. The net macro outcome thus depends on factors like skill levels, business adaptation, and policy responses.

The differences between the short-term and long-term effects of artificial intelligence on economic processes can be summarized as follows

Table 1. Short-term vs Long-term Economic Effects of Artificial Intelligence

Economic Dimension	Short-term Effects	Long-term Potential Effects
Productivity	Limited measurable impact; slow diffusion across firms	Significant productivity gains through automation and innovation
Employment	Minimal aggregate changes; task-level adjustments	Job transformation, creation of new roles, potential displacement of routine jobs
Innovation	Incremental improvements in processes and services	Emergence of new industries, business models, and markets
Firm Performance	Uneven gains; concentrated in early adopters	Broad efficiency improvements across sectors

Economic Dimension	Short-term Effects	Long-term Potential Effects
Economic Growth	Weak impact in macroeconomic data	Potential acceleration of long-term economic growth
Inequality	Limited visible effects so far	Risk of widening income and skill gaps if adaptation is uneven

Source: Author's synthesis based on recent literature.

As shown in Table 1, the current economic impact of AI remains limited in aggregate terms, while its long-term potential is considerably more significant, depending on the pace of adoption and structural adjustments.

Labor Market and Employment Effects

A core economic concern is labor. AI could displace some jobs while creating others. So far, evidence suggests the net effect has been modest. The Yale Budget Lab finds that as of early 2026, statistical measures of AI exposure show no significant change in employment or unemployment trends beyond what is already explained by pre-AI trends. In other words, the ongoing shifts in jobs seem consistent with historical dynamics, without a sudden AI-driven disturbance. Similarly, Goldman Sachs reports that while tech and creative sectors are seeing some displacement, there has been “no significant AI-led changes in the employment mix” in aggregate labor data to date. This aligns with surveys: executives generally do not yet see layoffs from AI; in fact, many expect a temporary *increase* in jobs related to AI infrastructure (building data centers, etc.).

On the other hand, AI is affecting the nature of work in certain roles. AI applications in customer service or programming can make some tasks more efficient. Studies at specific firms find that AI “helps workers with lower technical skills contribute to the innovation process”, and junior software developers report large gains in coding productivity. AI tools in fields like agriculture, health, or education are starting to augment workers’ capabilities (e.g., AI “avatars” in training electricians). These augmentations can raise aggregate productivity even if they do not immediately shrink headcounts.

Nevertheless, there are risks. AI may accentuate inequality: high-skill workers and firms that leverage AI effectively could capture most gains, while others fall behind. Some forecasting suggests up to ~25–50% of certain AI-exposed tasks might be automated in the next decade, potentially reducing entry-level job opportunities if not offset by new roles. Education and training will be critical: the consensus is that policy should focus on reskilling and education to prepare workers for evolving roles. Several reports (CBO, BIS) highlight that “AI preparedness” – having digital infrastructure and skills in place – is a key determinant of a country’s gains.

Sectoral and Functional Impacts

Beyond labor and macro, AI and tech transformations are remapping industries. In finance and accounting, AI tools automate data analysis and risk assessment; some studies report that AI adoption correlates with higher firm sales or valuations, though direct productivity measures are ambiguous. In logistics and supply chain, AI-driven optimization and predictive analytics are improving inventory management and routing. Manufacturing is seeing “smart factories” with IoT sensors and robotics driven by AI, which can enhance quality and yield. In services like tourism and health, AI-driven personalization (chatbots, diagnostic algorithms) is generating new business models.

It is important to note examples of positive change. For example, Land O’Lakes and Microsoft are using AI to help farmers increase crop yields and lower costs. Companies like Google report large productivity improvements from AI-assisted research and development, e.g., rapid drug discovery and protein folding breakthroughs. These domain-specific gains suggest that AI could yield “spectacular” productivity boosts at the microeconomic level. However, not every sector will benefit

equally. Any broad conclusion must consider complementarities: AI yields more when firms change their processes and workers learn new skills.

Policy and Future Directions

Given the breadth of effects, public policy plays a crucial role. Experts at Stanford emphasized that governments should manage AI's risks while maximizing benefits. This means investing in education, modernizing regulations (e.g., data, privacy, competition), and ensuring labor market support. Multidisciplinary cooperation is needed: finance regulators, labor agencies, and industry leaders must coordinate. The European Parliament briefing argues that with the right strategy, the EU can "direct AI onto a path that benefits its economy and citizens". Key policy areas include R&D funding, digital infrastructure, and safety nets for displaced workers.

It is also clear that continued research is needed. Most analysts note that we have seen only the early effects of current AI technologies, and much remains uncertain. Future empirical work should track sectoral output, productivity, wages, and inequality as more data becomes available. Interdisciplinary studies (combining economics, data science, management) will help unpack how exactly AI integrations change firm behavior. In summary, technology is rapidly evolving; the "headline" scenario of AI singularity is speculative, but the more measured scenario of gradual productivity gains appears plausible. Our article contributes to this by mapping the current evidence and highlighting avenues for monitoring AI's impact on economic processes.

Artificial Intelligence in Accounting and Implications for Training

Building on the general economic and sectoral impacts of artificial intelligence discussed above, it is essential to examine its implications at the organizational level, particularly in knowledge-intensive domains such as accounting.

The accounting field has been significantly influenced by technological transformations, particularly through the integration of artificial intelligence and automation tools. AI-based systems are increasingly used in financial data processing, auditing, forecasting, and decision support, leading to improved accuracy and efficiency.

These changes require a redefinition of the competencies needed by accounting professionals, shifting the focus from routine tasks to analytical thinking, digital skills, and strategic decision-making. As a result, professional training programs must adapt to these new requirements, incorporating digital tools and AI-based learning solutions.

The integration of artificial intelligence into training processes enables the personalization of learning experiences, allowing employees in accounting roles to develop relevant skills based on their individual needs and performance levels. This contributes to a more effective and sustainable approach to human resource development.

Based on the analysis conducted, a conceptual model can be proposed, highlighting the relationship between artificial intelligence, professional training, and human resource development. Artificial intelligence enables data-driven analysis of employee performance, which supports the design of personalized training programs. These programs contribute to the development of relevant competencies, ultimately leading to improved individual and organizational performance. This conceptual model contributes to the literature by integrating technological, educational, and human resource perspectives into a unified analytical framework.

Conclusions

Artificial intelligence and technological innovation have the potential to significantly reshape economic processes, but the magnitude and timing of these effects remain uncertain. The literature shows that, so far, AI has mainly generated hype: investments are up and some sectors have adopted AI, but measurable macroeconomic changes are minimal. In this article, we have reviewed evidence that AI can improve productivity in specific tasks and help democratize expertise among workers, yet

aggregate productivity growth and employment trends have barely budged. The discrepancy between expectations and outcomes echoes past technological waves (Solow's paradox).

Looking ahead, the potential impact of AI hinges on broader transformations: will firms reorganize, will workers acquire new skills, will policies adapt? The optimistic view is that AI, by automating routine tasks and enabling innovation, will boost output and create new industries (much as past technologies did). The cautious view warns that without addressing skill gaps and inequality, AI could exacerbate social problems. We find that most experts advocate neither fatalism nor blind faith. Rather, the consensus is to monitor developments closely and to proactively govern AI.

In conclusion, our research underscores that AI and technological change are double-edged for economic processes. They offer real opportunities to enhance efficiency and growth, but these gains will likely materialize gradually and unevenly. Policymakers and businesses should work together to strengthen infrastructure and education (so-called AI preparedness), to support workers in transition, and to foster innovation responsibly. Future research should track AI's diffusion using high-frequency data and explore sector-specific outcomes. By staying attuned to both the promises and pitfalls identified in the literature, stakeholders can contribute to more resilient and inclusive economic development as AI continues to evolve.

Furthermore, the study emphasizes that the effective integration of artificial intelligence into professional training systems is essential for supporting human resource development. In fields such as accounting, where technological transformations are rapidly evolving, the adoption of AI-driven and personalized learning solutions becomes a key factor in ensuring workforce adaptability and long-term organizational performance.

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ARTIFICIAL INTELLIGENCE AS A DRIVER OF HUMAN RESOURCE MANAGEMENT TRANSFORMATION: OPPORTUNITIES, RISKS AND STRATEGIC DIRECTIONS

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Abstract: *The rapid development of Artificial Intelligence (AI) is fundamentally reshaping organizational processes and redefining the role of Human Resource Management (HRM). This paper aims to analyze how HRM is being redesigned in the context of AI-driven transformation, focusing on key opportunities, associated risks, and strategic directions for sustainable organizational development.*

The study is based on a qualitative, conceptual methodology, using secondary data derived from international reports and indices, including the World Economic Forum's Future of Jobs Report, OECD well-being frameworks, International Labour Organization analyses, and European policy documents. In addition, insights from the banking sector are considered as an illustrative context due to its advanced level of AI adoption.

The findings indicate that AI enhances the efficiency of HR functions such as recruitment, performance management, and workforce analytics, while also enabling more personalized employee experiences. At the same time, the integration of AI introduces significant challenges, including algorithmic bias, ethical concerns, data privacy risks, and the potential depersonalization of workplace relationships.

The paper argues that HRM must evolve towards a strategic and integrative role, ensuring a balance between technological innovation and employee well-being. A conceptual perspective is proposed to support organizations in adapting HR practices to AI-driven environments while maintaining a human-centered approach and long-term performance.

Key words: *Artificial Intelligence, Human Resource Management, Digital Transformation, Organizational Performance, Employee Experience.*

JEL: M12, M54, O33.

Introduction

The rapid advancement of Artificial Intelligence (AI) is significantly transforming the organizational landscape, with profound implications for Human Resource Management (HRM). Despite the widely acknowledged benefits of artificial intelligence in human resource management, recent studies indicate that its adoption is often hindered by psychological and behavioral resistance among HR professionals, particularly in decision-making contexts such as recruitment (Revillod, 2024). This resistance, conceptualized as algorithmic aversion, reflects a tendency of individuals to prefer human judgment over algorithmic recommendations, even when the latter demonstrate superior predictive accuracy (Revillod, 2024). This perspective is also consistent with the Technology Acceptance Model, which suggests that perceived usefulness and perceived ease of use significantly influence individuals' acceptance of new technologies (Davis, 1989). As digital technologies become increasingly integrated into business operations, HR functions are being redefined, shifting from traditional administrative roles toward more strategic and data-driven approaches.

The relevance of this topic is underscored by recent global developments highlighted by World Economic Forum (WEF, 2023), which emphasizes the growing impact of AI on job structures and skills demand, as well as by OECD (2024), which stresses the importance of well-being in digitally

transformed work environments. These changes require organizations to reconsider how they manage human capital in order to remain competitive and sustainable.

An illustrative example of these transformations can be observed in the banking sector, where institutions are among the early adopters of AI technologies. The use of AI in areas such as data processing, risk assessment, and customer interaction has also generated significant implications for workforce management and HR practices.

The aim of this paper is to examine how HRM is being redesigned in the context of AI, identifying the main opportunities, risks, and strategic directions. The research adopts a conceptual and analytical approach, based on the synthesis of academic literature and international reports.

Basic content

Transformation of HRM functions under Artificial Intelligence

The integration of AI into HR processes has led to substantial changes in traditional HR functions. According to the World Economic Forum (WEF, 2023), AI-driven tools enable organizations to process large volumes of data, improving the efficiency and accuracy of recruitment and selection processes. In addition, people analytics facilitates evidence-based decision-making, enhancing performance management and workforce planning. Marler and Boudreau (2017) argue that HR analytics enables organizations to transform workforce data into strategic insights that support evidence-based human resource management. However, the integration of AI into HR processes is not solely a technological issue but also a behavioral one. Research highlights that HR professionals may exhibit resistance to algorithmic decision-making due to concerns related to data privacy, perceived threats to their professional roles, and the potential negative impact on their personal development and well-being (Revillod, 2024). In addition to improving efficiency, AI is increasingly reshaping the nature of decision-making within HRM. Advanced analytics tools enable predictive modelling, allowing organizations to anticipate employee turnover, identify high-potential talent, and optimize workforce allocation. According to recent findings, organizations that effectively use people analytics report higher levels of productivity and employee engagement (WEF, 2023).

Moreover, AI contributes to the transition from reactive to proactive HR practices. Instead of responding to workforce issues after they occur, HR departments can use AI-driven insights to design preventive strategies, particularly in areas such as employee retention and well-being. This shift represents a fundamental transformation in the strategic role of HRM.

AI also supports the personalization of learning and development processes by tailoring training programs to individual employee needs. The International Labour Organization (2021) highlights the importance of digital technologies in expanding access to continuous learning and reskilling opportunities. Nevertheless, empirical evidence suggests that the relationship between digital HRM tools and employee performance and engagement is not always direct, being significantly mediated by organizational culture, leadership practices, and managerial approaches (Stachová et al., 2024). This indicates that technological adoption alone is insufficient to ensure improved performance outcomes, highlighting the importance of complementary human-centered management practices (Stachová et al., 2024).

In the banking sector, these transformations are particularly visible, as institutions increasingly rely on AI for automating repetitive tasks and improving operational efficiency. This, in turn, reshapes job roles and requires HR departments to focus more on strategic workforce planning and skills development.

The paper contributes to the current discussion on AI-driven HRM transformation by integrating perspectives from both general organizational environments and the banking sector as an illustrative context of accelerated digitalization.

Skills transformation and the future workforce

One of the most significant implications of AI adoption is the transformation of skill requirements. The World Economic Forum (WEF, 2023) estimates that a substantial proportion of jobs will undergo

structural changes, requiring new digital, analytical, and socio-emotional skills. In this context, HRM plays a critical role in managing reskilling and upskilling processes.

Digital literacy, data interpretation, and adaptability are becoming essential competencies across all organizational levels. Recent studies emphasize that continuous digital upskilling and lifelong learning have become essential conditions for workforce adaptability in AI-driven environments (Schwab, 2020). At the same time, human-centric skills such as critical thinking, emotional intelligence, and collaboration remain crucial, particularly in environments where AI systems are integrated into daily work processes.

In sectors such as banking, this transformation is particularly evident, as employees are required to combine financial expertise with digital capabilities. This dual skill requirement further emphasizes the strategic importance of HRM in workforce development.

AI adoption in the banking sector: implications for HRM

The banking sector represents one of the most advanced environments in terms of Artificial Intelligence adoption, due to its high level of digitalization, strong regulatory framework, and data-intensive operations. Financial institutions increasingly rely on AI technologies for processes such as credit risk assessment, fraud detection, customer service automation, and advanced data analytics. These developments have direct implications for Human Resource Management. On the one hand, the automation of repetitive and transactional tasks reduces the demand for routine roles. On the other hand, it increases the need for employees with advanced digital, analytical, and problem-solving skills.

As a result, HRM in the banking sector is undergoing a structural transformation, shifting its focus from operational workforce management toward strategic talent development. This includes large-scale reskilling initiatives, the integration of digital competencies into job profiles, and the redesign of career paths.

Furthermore, the highly regulated nature of the banking industry requires organizations to ensure transparency, accountability, and compliance when implementing AI-based solutions. In this context, HR departments play a dual role: facilitating digital transformation while maintaining ethical standards and workforce stability.

Risks and challenges associated with AI in HRM

Despite its numerous benefits, the use of AI in HRM raises several critical challenges. One of the most significant concerns is algorithmic bias, which can lead to unintended discrimination in recruitment and evaluation processes, as noted by the European Commission (2019). Additionally, the extensive use of employee data introduces risks related to privacy and data protection.

Another important issue is the potential depersonalization of workplace relationships. Davenport and Ronanki (2018) argue that excessive reliance on digital tools may reduce interpersonal interactions, affecting organizational culture and employee engagement.

A further important challenge concerns employee trust in AI systems. The limited transparency of algorithmic decision-making may generate scepticism and resistance among employees, especially when outcomes directly affect careers or performance evaluations. In this context, trust becomes a key factor influencing the successful integration of AI into HR processes.

At the same time, the ethical governance of AI has emerged as a critical organizational responsibility. It is essential for organizations to establish clear accountability frameworks, ensuring that AI systems operate in alignment with both legal requirements and organizational values. According to Floridi et al. (2018), ethical AI governance requires the integration of principles such as transparency, accountability, fairness, and human oversight into organizational decision-making systems. This includes regular algorithm audits and the incorporation of fairness criteria into decision-making processes.

Furthermore, the World Health Organization (2022) emphasizes the impact of digitalization on mental health, including increased risks of stress and burnout in highly technology-driven environments.

These challenges are also evident in the banking sector, where the rapid adoption of AI requires careful management of organizational change and employee adaptation. In addition, the pace of AI adoption may create disparities within the workforce, particularly between employees with advanced digital skills and those with limited technological competencies. This can lead to internal inequalities, reduced job security, and increased resistance to change. This phenomenon can be further explained through the concept of the intra-organizational digital divide, which refers to disparities in employees' access to digital tools, technological competencies, and the ability to effectively use digital resources (Zervas & Stiakakis, 2025). Such inequalities may influence not only individual performance but also perceptions of fairness and inclusion within the organization, thereby affecting overall human resource performance (Zervas & Stiakakis, 2025).

Moreover, the continuous monitoring enabled by AI systems may contribute to perceived over-control, affecting employee autonomy and motivation. Therefore, organizations must carefully balance efficiency gains with the preservation of employee trust and psychological well-being.

The dual nature of Artificial Intelligence in HRM, characterized by both significant opportunities and potential risks, can be structured as presented in Table 1.

Table 1. Opportunities and risks of Artificial Intelligence in Human Resource Management

Dimension	Opportunities of AI in HRM	Risks of AI in HRM	Strategic HR Response
Recruitment & Selection	Faster processing of applications; improved candidate matching	Algorithmic bias; lack of transparency	Implement ethical AI frameworks; ensure human oversight
Performance Management	Real-time monitoring; data-driven decisions	Over-surveillance; increased employee stress	Balance monitoring with trust; ensure transparency
Learning & Development	Personalized training; continuous learning opportunities	Over-reliance on technology; reduced human interaction	Combine digital tools with human mentoring
Employee Experience	Enhanced engagement through personalization	Depersonalization of work relationships	Promote human-centered HR practices
Data Management	Better workforce insights; predictive analytics	Data privacy and security risks	Strengthen data protection policies
Organizational Culture	Innovation and agility	Resistance to change; lack of trust	Foster digital culture and change management
Work-Life Balance	Flexible work arrangements enabled by AI	Blurred boundaries between work and personal life	Implement clear work-life balance policies

Source: developed by the author based on World Economic Forum (2023), OECD (2024), ILO (2021), and European Commission (2019)

As illustrated in Table 1, the successful integration of AI in HRM depends on the ability of organizations to balance technological advantages with ethical considerations and employee well-being.

Ethical and governance challenges of AI in HRM

Beyond operational risks, the integration of AI in HRM raises complex ethical and governance challenges. The increasing reliance on algorithmic decision-making requires organizations to ensure transparency, accountability, and fairness in all HR-related processes.

A key issue is the "black box" nature of many AI systems, which makes it difficult to understand how decisions are made. This lack of transparency can undermine employee trust and create legal and reputational risks for organizations. Therefore, HR departments must collaborate closely with IT and compliance functions to establish clear governance frameworks.

In highly regulated sectors such as banking, these challenges are even more pronounced, as organizations must comply with strict regulatory standards while implementing advanced technologies. This reinforces the need for a responsible and human-centered approach to AI adoption.

Strategic directions for redesigning HRM

In response to these transformations, HRM must evolve toward a more strategic and integrative role within organizations. Ulrich (1997) emphasizes that HR professionals must move beyond administrative functions and become strategic partners capable of supporting organizational transformation and long-term competitiveness. Kaplan and Norton (1992) highlight that performance measurement systems play a critical role in aligning organizational strategy with operational outcomes. In this context, HRM contributes to ensuring that AI-driven initiatives are effectively integrated into broader organizational performance frameworks. The Organisation for Economic Co-operation and Development (OECD, 2024) highlights that employee well-being is a critical determinant of long-term organizational performance, particularly in digital contexts.

Similarly, the Work-Life Balance Directive introduced by the European Commission (2019) underscores the need for organizations to implement policies that support employees in balancing professional and personal life. The findings of this study are consistent with recent research indicating that the adoption of AI-based HR practices is influenced not only by technological factors but also by employees' perceptions and psychological responses, including algorithmic aversion (Revillod, 2024).

Key strategic directions for HRM include:

- ensuring the ethical and responsible use of AI;
- fostering digital and adaptive skills among employees;
- maintaining a human-centered approach in HR practices;
- promoting work-life balance and employee well-being.

These directions are particularly relevant in highly digitalized sectors such as banking, where organizations must balance technological innovation with regulatory requirements and long-term workforce sustainability.

At the same time, organizations are increasingly adopting hybrid approaches that combine human judgment with AI-based recommendations. This "human-in-the-loop" model ensures that critical decisions remain under human control while benefiting from the analytical capabilities of AI. Such approaches are especially important in regulated environments, where transparency, accountability, and trust are essential.

Furthermore, HR professionals must reinforce the human dimension of organizations by promoting trust, communication, and inclusive work environments. This balance between technological integration and human-centered management represents a key condition for sustainable organizational performance in the AI era. Moreover, addressing digital inequalities within organizations becomes essential, as differences in digital competencies and access to technology may create performance gaps and affect employees' overall contribution to organizational outcomes (Zervas & Stiakakis, 2025).

Furthermore, Bughin et al. (2017) highlight that AI adoption is expected to significantly transform job structures and workforce requirements across industries. Moreover, the results support the argument that digitalization alone does not automatically lead to improved performance, as its effectiveness is highly dependent on organizational and managerial contexts (Stachová et al., 2024). The relationship between Artificial Intelligence and Human Resource Management transformation can be conceptually structured as illustrated in Figure 1. The model highlights the role of AI as a key

driver influencing the transformation of core HR functions, including recruitment, performance management, and employee development. This transformation generates specific employee outcomes, such as increased engagement, improved well-being, and enhanced adaptability, which ultimately contribute to organizational performance.

In addition, the model emphasizes the importance of contextual factors. Enablers such as ethical governance, data security, and organizational culture support the effective implementation of AI, while moderators—including regulatory frameworks and industry-specific characteristics, such as those found in the banking sector—shape the extent and impact of these transformations.

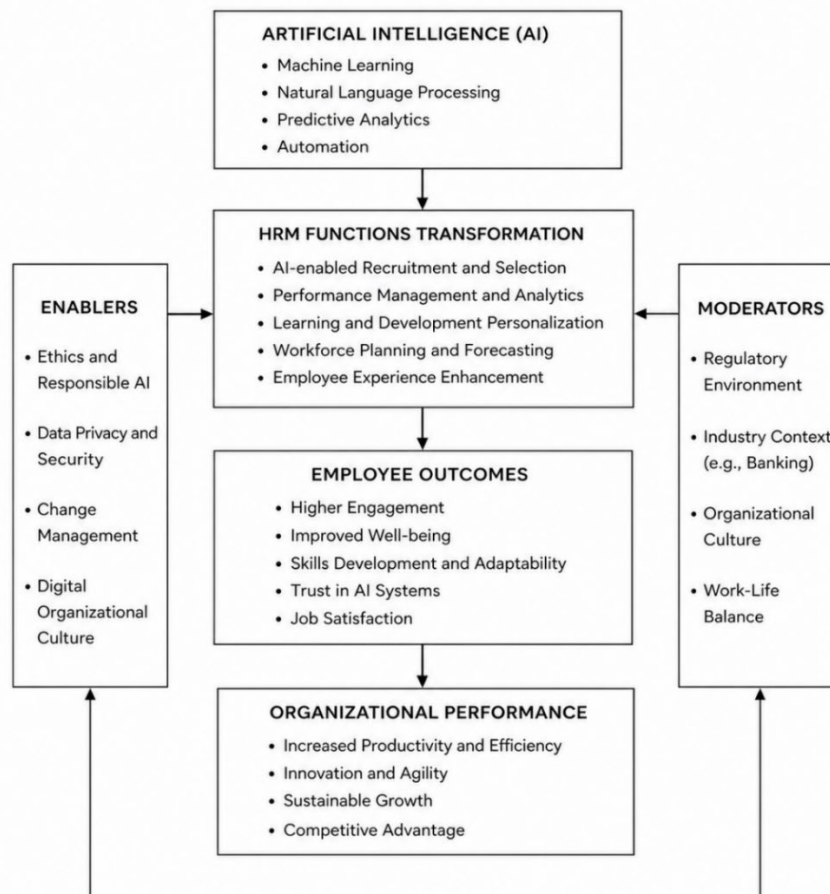


Figure 1. Conceptual Model of AI-Driven HRM Transformation

Source: developed by the author based on WEF (2023), OECD (2024), ILO (2021)

The evolving role of HR professionals in the AI Era

The integration of Artificial Intelligence is not only transforming HR processes but also redefining the role of HR professionals. Traditionally focused on administrative and operational tasks, HR practitioners are increasingly expected to act as strategic partners, capable of managing complex organizational transformations.

In the AI-driven context, HR professionals must develop new competencies, including data literacy, digital awareness, and the ability to interpret AI-generated insights. At the same time, they must strengthen their role in areas that cannot be replaced by technology, such as leadership, communication, and organizational culture development.

This dual role—combining technological understanding with human-centered management—positions HR as a key driver of sustainable organizational performance in the digital age.

Conclusions

The analysis demonstrates that Artificial Intelligence represents a key driver of transformation in Human Resource Management. While AI offers significant opportunities for improving efficiency and enhancing employee experience, it also introduces complex challenges that require careful consideration.

A central conclusion of this study is that the successful integration of AI depends on the ability of organizations to balance technological advancement with the human dimension of work. In this context, HRM must strengthen its strategic role, acting as a bridge between digital transformation and employee well-being.

The main limitation of this research lies in its conceptual nature and the absence of empirical data. Future research should focus on empirical investigations at the organizational level, particularly within specific sectors such as banking, in order to validate and refine the proposed perspectives and provide deeper insights into the practical implications of AI-driven HRM transformation. Such studies could contribute to the development of more targeted and effective human resource strategies in increasingly digitalized environments.

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ENHANCING HUMAN RESOURCES PERFORMANCE THROUGH WORK–LIFE BALANCE MANAGEMENT: A GLOBAL PERSPECTIVE BASED ON INTERNATIONAL REPORTS

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Abstract: *In the context of globalization, digital transformation, and evolving labor market dynamics, work–life balance has emerged as a strategic priority for organizations aiming to enhance human resources performance and ensure sustainable development. This paper aims to examine the role of work–life balance management in improving employee productivity, well-being, and organizational efficiency. The study adopts a qualitative and exploratory research approach, based on a comprehensive review of recent scientific literature and international reports. The analysis relies on data provided by reputable institutions, including Eurofound, the Organisation for Economic Co-operation and Development (OECD), the International Labour Organization (ILO), the World Economic Forum (WEF), the World Health Organization (WHO), the European Commission, and the Global Work–Life Balance Index (Remote, 2023). The findings indicate that the implementation of effective work–life balance policies—such as flexible work arrangements, remote work, parental leave, and employee well-being initiatives—contributes significantly to increased job satisfaction, productivity, and organizational resilience. Furthermore, these practices support sustainable human resource management and foster innovation in the modern workplace. By synthesizing global trends and policy frameworks, this paper provides valuable insights for organizations, policymakers, and researchers. The study contributes to the theoretical and methodological foundation of doctoral research focused on enhancing human resources performance through the effective management of work–life balance, offering directions for future empirical investigations.*

Key words: *work–life balance; human resources performance; employee well-being; organizational performance; sustainable human resource management; future of work.*

JEL: M12; M54; J24; J28; O15.

Introduction

In the context of globalization, digital transformation, and continuous changes in labor market dynamics, human resources have become a key determinant of organizational competitiveness and sustainable development. In this framework, work–life balance (WLB) has gained increasing importance as a strategic factor influencing employee well-being, productivity, and overall organizational performance. The growing complexity of professional roles, combined with the blurring boundaries between work and personal life, has intensified the need for effective work–life balance management both at organizational and policy levels.

The relevance of the topic is further reinforced by recent global trends, including the expansion of remote and hybrid work models, accelerated by digitalization and the COVID-19 pandemic. These transformations have significantly altered traditional working patterns, increasing both flexibility and work-related pressures. According to the International Labour Organization, excessive working hours and insufficient rest negatively affect employee health, productivity, and performance (ILO, 2022). Similarly, the World Health Organization highlights that long working hours are associated with increased health risks, including stress, burnout, and cardiovascular diseases (WHO, 2021). These findings emphasize the critical role of work–life balance in ensuring a sustainable and healthy workforce.

The motivation for choosing this research topic derives from the growing need to identify effective mechanisms for enhancing human resources performance in modern organizations. In the context of increasing competition and workforce expectations, organizations are required to implement innovative human resource management practices that support both employee well-being and organizational efficiency. International reports underline that work–life balance is a key component of overall life satisfaction and labor productivity (OECD, 2024), while flexible working arrangements contribute significantly to employee engagement and organizational resilience (Eurofound, 2023).

The main aim of this paper is to analyze the role of work–life balance management in enhancing human resources performance by examining global trends, policy frameworks, and best practices. In order to achieve this aim, the study addresses the following research objectives: (1) to define the conceptual framework of work–life balance and its relationship with human resources performance; (2) to analyze international reports and indices related to work–life balance; and (3) to identify the implications of work–life balance policies for organizational performance and sustainability.

From a methodological perspective, the research is based on a qualitative and exploratory approach, relying on the analysis and synthesis of secondary data. The study uses a systematic review of scientific literature and international reports published by reputable organizations such as the Organisation for Economic Co-operation and Development (OECD), Eurofound, the International Labour Organization (ILO), the World Economic Forum (WEF), the World Health Organization (WHO), and the European Commission. This approach allows for the identification of key trends, patterns, and relationships between work–life balance and human resources performance at a global level.

Regarding the stage of research, the topic of work–life balance has been extensively explored in the academic literature, with numerous studies highlighting its impact on job satisfaction, employee well-being, and organizational outcomes. For instance, research conducted by Haar et al. (2014) demonstrates that work–life balance is positively associated with job satisfaction, life satisfaction, and mental health. Similarly, Kossek and Lee (2017) emphasize the role of work–life balance in promoting sustainable workforce development and organizational performance. More recent studies also highlight the importance of flexible work arrangements and digital work environments in shaping employee experiences and productivity (WEF, 2023).

In this context, the present paper contributes to the existing body of knowledge by providing a comprehensive synthesis of global perspectives on work–life balance and its implications for human resources performance. Furthermore, it establishes a theoretical and methodological foundation for future empirical research, particularly in the context of emerging labor market trends and evolving organizational practices.

Basic content

Conceptual Framework of Work–Life Balance and Human Resources Performance

Work–life balance (WLB) has evolved into a central concept within contemporary human resource management, reflecting the ability of individuals to effectively manage professional responsibilities alongside personal and family life. In modern organizations, WLB is no longer perceived merely as a social benefit, but as a strategic instrument for enhancing employee performance and organizational sustainability.

From a theoretical perspective, work–life balance is closely associated with role theory and the concept of work–family conflict, which suggests that incompatible demands between work and personal roles can negatively affect employee well-being and performance (Allen et al., 2000). Conversely, the achievement of balance between these domains contributes to improved psychological well-being, increased job satisfaction, and higher levels of organizational commitment. Empirical studies confirm that employees who experience a satisfactory level of work–life balance demonstrate significantly better outcomes in terms of performance and well-being. Haar et al. (2014) highlight that work–life balance is positively correlated with job satisfaction, life satisfaction, and

mental health across different cultural contexts. Moreover, Greenhaus and Allen (2011) emphasize that achieving balance between professional and personal roles leads to enhanced individual and organizational outcomes.

In addition to role theory, recent research emphasizes the relevance of the Job Demands–Resources (JD-R) model, which explains how job demands (e.g., workload, time pressure) and job resources (e.g., flexibility, autonomy, organizational support) interact to influence employee performance and well-being. Within this framework, work–life balance practices are considered critical organizational resources that mitigate stress and prevent burnout, while simultaneously enhancing motivation and engagement. According to Bakker and Demerouti (2007), the balance between job demands and organizational resources plays a critical role in preventing burnout and sustaining employee engagement and performance.

Moreover, the increasing integration of digital technologies into the workplace has led to the emergence of the concept of “always-on culture”, where employees remain permanently connected to work-related tasks. While digitalization offers flexibility, it also creates challenges for maintaining clear boundaries between work and personal life, reinforcing the importance of structured work–life balance policies (WEF, 2023).

In this context, work–life balance represents a key component of sustainable human resource management, contributing to long-term organizational success by improving employee engagement, reducing turnover, and fostering a supportive organizational culture. This perspective is also supported by Kramar (2014), who argues that sustainable human resource management emphasizes the long-term well-being of employees as a prerequisite for organizational sustainability and competitiveness.

Global Trends in Work–Life Balance: Evidence from International Reports

International organizations have increasingly recognized work–life balance as a critical factor influencing both individual well-being and macroeconomic performance. Global reports and indices provide comprehensive insights into the dynamics of work–life balance and its implications for human resources performance.

According to the Organisation for Economic Co-operation and Development, work–life balance is a core dimension of overall well-being, emphasizing the importance of balancing working time with personal life in order to increase productivity and life satisfaction (OECD, 2024). Similarly, Eurofound highlights that flexible working arrangements, such as telework and flexible schedules, contribute significantly to employee engagement and organizational resilience (Eurofound, 2023). This general perspective can be further substantiated through comparative cross-country evidence, which highlights significant differences in work–life balance outcomes.

Recent global evidence also indicates a growing polarization in work–life balance outcomes across countries and sectors. High-income economies tend to offer more flexible work arrangements and stronger institutional support, while employees in emerging economies often face longer working hours and limited access to work–life balance policies (OECD, 2024).

Furthermore, the post-pandemic period has revealed a paradox: although remote work increased flexibility, it also intensified work-related stress for many employees due to the lack of clear boundaries and increased workload (Eurofound, 2023). This dual effect highlights the need for organizations to move beyond flexibility alone and adopt integrated well-being strategies.

The International Labour Organization stresses that excessive working hours and inadequate rest periods negatively affect employee health and productivity, underlining the need for policies that ensure decent work conditions (ILO, 2022). In the same vein, the World Health Organization demonstrates that long working hours are associated with increased risks of burnout and serious health conditions, reinforcing the importance of work–life balance policies (WHO, 2021).

Furthermore, the World Economic Forum emphasizes that the future of work is increasingly shaped by digitalization, automation, and flexible employment models, which require organizations to adopt

innovative and employee-centered human resource practices (WEF, 2023). At the European level, the Work–Life Balance Directive (EU) 2019/1158 promotes gender equality and supports the implementation of family-friendly policies, including parental leave and flexible work arrangements (European Commission, 2019).

To synthesize these perspectives, Table 1 presents a comparative analysis of major international organizations and their contributions to the development of work–life balance frameworks. The table includes key institutions such as the Organisation for Economic Co-operation and Development (OECD), Eurofound (European Foundation for the Improvement of Living and Working Conditions), the International Labour Organization (ILO), the World Economic Forum (WEF), the European Commission, the World Health Organization (WHO), and Remote.

The purpose of this table is to consolidate global perspectives on work–life balance and to highlight its implications for human resources performance. The analysis demonstrates that the implementation of policies such as flexible working arrangements, remote work, parental leave, and employee well-being initiatives contributes significantly to increased productivity, job satisfaction, and organizational resilience. Therefore, work–life balance is not only a social objective but also a strategic driver of organizational performance and sustainability.

Table 1. Global Perspectives on Work–Life Balance and Human Resources Performance

Organization	Abbreviation	Report/Index	Key Focus	Implications for HR Performance
Organisation for Economic Co-operation and Development	OECD	How's Life? 2024; Better Life Index	Work–life balance and well-being	Increased productivity and life satisfaction
European Foundation for the Improvement of Living and Working Conditions	Eurofound	Living and Working in Europe 2023; EWCS	Working conditions and flexibility	Higher employee engagement and resilience
International Labour Organization	ILO	Working Time and Work–Life Balance Around the World	Decent work and working time	Improved health and workforce efficiency
World Economic Forum	WEF	Future of Jobs Report 2023	Digitalization and future skills	Innovation and adaptability
European Commission	European Commission	Directive (EU) 2019/1158	Work–life balance policies	Inclusive and sustainable HR practices
World Health Organization	WHO	Long Working Hours and Health	Occupational health	Reduced stress and burnout
Remote (Company)	Remote	Global Work–Life Balance Index 2023	Global benchmarking	Improved retention and performance

Source: Developed by the author based on OECD (2024), Eurofound (2023), ILO (2022), WEF (2023), European Commission (2019), WHO (2021), and Remote (2023).

A closer examination of the data presented in Table 1 reveals a convergence of perspectives across international organizations, despite differences in their institutional focus. While economic institutions such as OECD emphasize productivity and well-being, organizations like ILO and WHO focus primarily on health and labor conditions. This convergence suggests that work–life balance should be approached as a multidimensional construct, integrating economic, social, and health-related dimensions. Consequently, effective work–life balance management requires coordinated

efforts at both organizational and policy levels, ensuring alignment between productivity objectives and employee well-being.

Impact of Work–Life Balance on Human Resources Performance

The relationship between work–life balance and human resources performance has been widely examined in recent academic literature. Research findings consistently indicate that organizations implementing effective work–life balance policies achieve higher levels of employee performance, engagement, and retention. Previous meta-analytical research also demonstrates a strong positive relationship between employee engagement, job satisfaction, and organizational performance outcomes (Harter et al., 2002).

Flexible work arrangements, including remote work and hybrid models, have become essential tools for enhancing organizational performance. These practices allow employees to better manage their professional and personal responsibilities, leading to improved productivity and job satisfaction. Wang et al. (2021) demonstrate that remote work, when properly managed, can positively influence both employee performance and well-being. However, recent studies also highlight that flexible work arrangements may generate unintended consequences if not properly managed. Excessive flexibility can lead to blurred boundaries between professional and personal life, increased workload, and higher levels of stress, particularly in remote work settings (Eurofound, 2023). Similar findings were reported by Ipsen et al. (2021), who identified both increased flexibility and higher psychological strain as major consequences of working from home during the post-pandemic period. This suggests that the effectiveness of work–life balance policies depends not only on their implementation, but also on the organizational context and managerial practices.

An important emerging trend in the literature is the recognition of work–life balance as a determinant of **organizational resilience**. Organizations that actively support employee well-being are better equipped to respond to external shocks, such as economic crises or labor market disruptions.

Based on recent international evidence, work–life balance is increasingly recognized as a key determinant of both individual well-being and labor market performance. OECD data indicate that employees working excessive hours report significantly lower levels of life satisfaction and productivity, while countries with more balanced working time arrangements tend to achieve better overall socio-economic outcomes (OECD, 2024). Similarly, Eurofound findings show that access to flexible work arrangements and supportive working conditions is positively associated with higher employee engagement, reduced stress levels, and improved job quality (Eurofound, 2023). For example, OECD data reveal that countries such as Germany and the Netherlands, characterized by shorter average working hours, report higher levels of work–life balance and employee well-being compared to countries with longer working hours, such as Mexico or South Korea (OECD, 2024). Beyond these cross-country differences, work–life balance also has broader implications at the macroeconomic level.

From a macroeconomic perspective, work–life balance is increasingly associated with labor market sustainability and long-term productivity growth. Countries characterized by stronger work–life balance outcomes tend to report higher levels of overall well-being and more stable workforce participation (OECD, 2024). This reinforces the idea that work–life balance is not only an organizational concern but also a broader economic priority.

Additionally, work–life balance plays a crucial role in **talent attraction and retention**, particularly among younger generations (e.g., Millennials and Generation Z), who place greater emphasis on flexibility, autonomy, and quality of life. As a result, organizations that fail to integrate work–life balance into their human resource strategies risk losing competitiveness in the global talent market. This trend is further amplified by the changing expectations of the modern workforce, where employees increasingly value meaningful work, flexibility, and psychological well-being over traditional financial incentives. As a result, work–life balance has become a key element of employer branding and organizational attractiveness in competitive labor markets.

In addition, work–life balance contributes to reducing absenteeism, turnover, and burnout, which are critical factors affecting organizational efficiency. Kossek and Lee (2017) argue that integrating work–life balance into human resource management strategies supports sustainable workforce development and long-term organizational success.

Therefore, work–life balance should be considered a strategic investment in human capital rather than a cost. Organizations that prioritize employee well-being and flexibility are better positioned to adapt to changing labor market conditions, attract talent, and maintain competitive advantage in the global economy.

In this context, the relationship between work–life balance and performance should be understood as a dynamic and multidimensional process, influenced by both individual and organizational factors. The relationships between work–life balance and human resources performance are further illustrated in Figure 1.

The model highlights the key organizational and structural factors influencing work–life balance, including flexible work arrangements, workload, organizational support, and digitalization. These factors interact in a cumulative manner, contributing to employee well-being and job satisfaction, which ultimately translate into enhanced human resources performance and improved organizational outcomes.

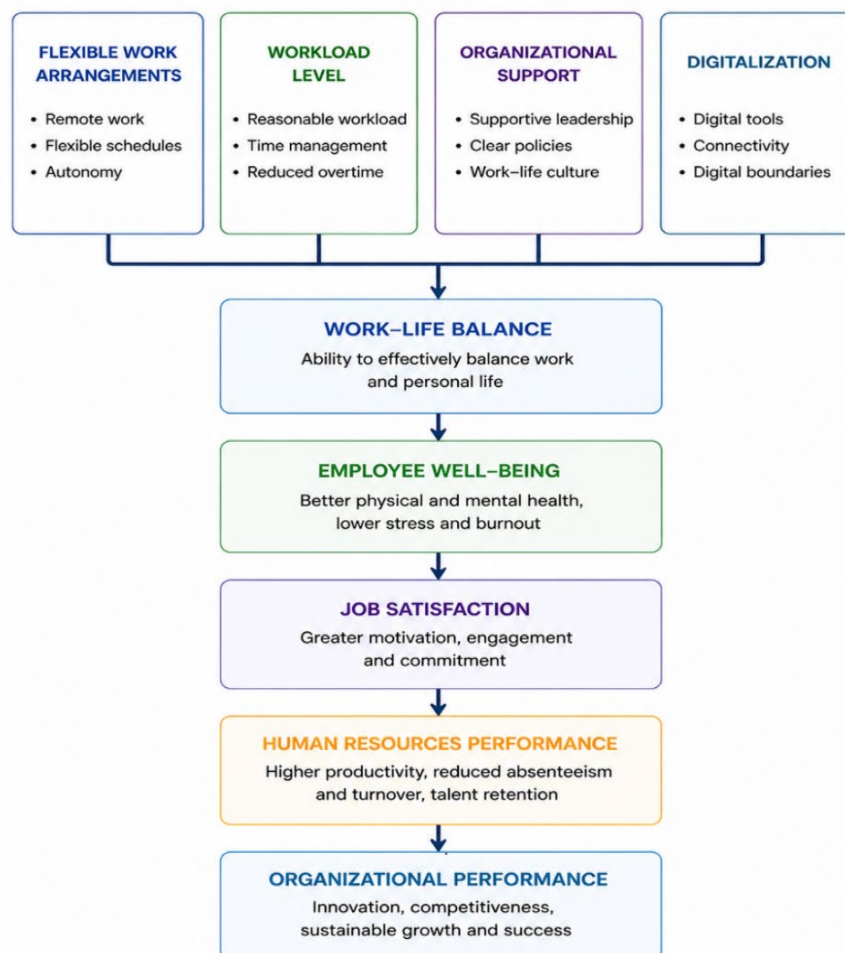


Figure 1. Key Factors Influencing Work–Life Balance and Human Resources Performance

Source: Developed by the author based on OECD (2024), ILO (2022), and WEF (2023).

Conclusions

The present study has highlighted the growing importance of work–life balance as a strategic determinant of human resources performance in the context of contemporary labor market transformations. Based on the analysis of international reports and recent academic literature, the findings confirm that effective work–life balance management contributes significantly to enhancing employee well-being, job satisfaction, productivity, and organizational performance.

The research has demonstrated that work–life balance is a multidimensional construct influenced by organizational, individual, and contextual factors. Flexible work arrangements, supportive organizational practices, and the integration of digital technologies play a crucial role in shaping employee experiences and performance outcomes. At the same time, the study emphasizes that work–life balance should not be approached solely as a social benefit, but rather as a strategic investment in human capital and organizational sustainability.

At a broader level, the analysis of international data provided by institutions such as OECD and Eurofound has shown that work–life balance is also closely linked to macroeconomic outcomes, including labor market stability, workforce participation, and long-term productivity growth. These findings reinforce the relevance of work–life balance not only at the organizational level but also within the framework of public policies and socio-economic development.

However, the study also highlights that the implementation of work–life balance policies is not without challenges. In particular, the expansion of remote and hybrid work models has revealed potential limitations, such as blurred boundaries between work and personal life, increased workload, and the risk of work intensification. These aspects underline the importance of adopting a balanced and context-specific approach to work–life balance management, supported by clear organizational policies and effective managerial practices.

Despite its contributions, this research is subject to several limitations. First, the study is based exclusively on secondary data and does not include empirical evidence at the organizational or national level. Second, the analysis focuses primarily on global trends, without addressing in detail the specific characteristics of individual countries or sectors. Third, the rapid evolution of work patterns and technological developments may limit the long-term applicability of some findings.

In this context, future research directions should focus on empirical investigations at the organizational level, particularly in emerging economies, in order to better understand the specific determinants and outcomes of work–life balance. Further studies could also explore the role of leadership, organizational culture, and digital transformation in shaping work–life balance practices. In addition, comparative analyses across industries and countries would provide valuable insights into the contextual factors influencing the effectiveness of work–life balance policies.

In conclusion, the study contributes to the existing body of knowledge by providing a comprehensive synthesis of global perspectives on work–life balance and its impact on human resources performance. It also offers a conceptual and methodological foundation for future research, highlighting the need for integrated and adaptive approaches to managing the relationship between work and personal life in an increasingly complex and dynamic work environment.

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STATE-OWNED ENTERPRISES AS CATALYSTS OF CORPORATE BOND MARKET DEVELOPMENT IN MOLDOVA

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Abstract: *This paper examines how state-owned enterprises (SOEs) in the Republic of Moldova can accelerate domestic capital-market development through the issuance of corporate bonds. Building on prior empirical work that identified a mutually reinforcing relationship between SOE reform and capital-market reform in Moldova, the article develops a deeper policy and market-design framework focused on corporate bonds. The analysis combines Moldova-specific financial and institutional evidence with international experience from state-owned and state-controlled issuers, including Baltic energy utilities, Singapore's Temasek, Chile's Codelco, France's EDF, and Central and Eastern European energy transition bond issuers. The paper argues that SOE bond issuance can be an effective market-development instrument when four conditions are met: commercially credible issuers, transparent ownership and governance, disciplined project selection, and a predictable issuance and post-issuance disclosure regime. For Moldova, SOE bonds could help diversify financing away from bank lending, lengthen maturities for infrastructure and utility investment, improve the public accountability of large SOEs, and crowd in private issuers by creating benchmarks, investor familiarity, and intermediation capacity. The paper estimates that the initial group of financially stronger SOEs identified in previous work has a theoretical issuance potential of approximately MDL 5.1 billion, a scale large enough to materially increase the supply of domestic securities if implemented gradually and with safeguards. The proposed roadmap recommends a sequenced pilot programme anchored in one or two investment-grade-like SOEs, mandatory independent audit, use-of-proceeds discipline, credit-risk assessment, public disclosure, exchange listing, central securities depository settlement, and a post-issuance monitoring framework.*

Key words: *state-owned enterprises; corporate bonds; capital market development; corporate governance; financial intermediation*

JEL: L32, L51, L53.

Introduction

Moldova faces two structural constraints that are usually treated separately: an extensive but weakly performing SOE sector and a shallow capital market with few issuers, few instruments and limited liquidity. The policy opportunity is to connect them. Selected SOEs can issue corporate bonds to finance commercially viable investment projects, while the domestic market gains larger and more recognizable instruments. This paper describes the opportunities and prospects of SOEs to issue corporate bonds in Moldova as a precondition for boosting the domestic capital market.

The relevance of SOE bonds is particularly strong in small bank-dominated economies. Investors cannot learn to price corporate risk without credible issuers; intermediaries cannot build underwriting capacity without transactions; and regulators cannot refine disclosure standards if issuance remains marginal. SOEs can help overcome this coordination problem because some have scale, recognizable brands, stable cash flows and public-policy relevance. Yet public ownership is not a guarantee of credit quality. If governance is politicized, tariffs are distorted, public-service obligations are unfunded or debt is assumed to be implicitly guaranteed by the state, SOE bonds may create fiscal and reputational risks instead of market development.

The central research question is therefore not whether SOEs can issue bonds, but under what conditions they should do so. The paper answers four questions: what international practices are most relevant; what advantages bonds provide to the Moldovan SOE sector; how issuance can affect capital-market development; and what procedures SOEs should follow. The contribution is both analytical and operational. It links financial-development theory, OECD and World Bank SOE governance principles, international issuer practice and Moldova-specific evidence into a practical issuance roadmap.

Literature and analytical framework

The finance-and-growth literature shows that financial systems support growth by mobilizing savings, producing information about investment opportunities, monitoring managers, allocating capital and facilitating risk management (Levine, 2005; Beck, Levine and Loayza, 2000). In bank-dominated systems these functions are performed mainly through credit. A deeper system also needs securities markets. Government bonds establish a yield curve; equities support risk-sharing and corporate control; and corporate bonds provide market-based debt finance that can lengthen maturities, reduce dependence on collateral-based loans and create observable prices for credit risk. Corporate bonds are especially relevant for infrastructure and utility investment because project benefits often mature more slowly than bank loan tenors. A bond converts a bilateral lending decision into a standardized instrument that can be purchased by households, banks, insurers, investment funds and other institutional investors. It also creates a public credit story: audited accounts, risk factors, use of proceeds, repayment sources and continuing disclosure. These requirements can improve governance when the issuer expects repeated market access.

SOE governance literature adds a second dimension. The OECD Guidelines on Corporate Governance of State-Owned Enterprises and the World Bank SOE toolkit emphasize clear ownership rationales, separation of ownership, policy and regulatory functions, professional boards, competitive neutrality, transparency, internal controls and performance monitoring. Bond issuance can reinforce these principles because investors will not finance opaque companies indefinitely. However, bonds may also create quasi-sovereign moral hazard. Investors may price SOE debt as if the state will rescue the issuer, even when no legal guarantee exists. Best practice therefore requires explicit disclosure of guarantee status, public-service obligations, tariff rules, related-party transactions and fiscal-risk monitoring.

The analytical framework used here is a five-stage SOE bond development chain. First, the state selects SOEs with eligible legal form, moderate leverage, reliable cash flows and commercially credible projects. Second, selected SOEs upgrade governance, audit, disclosure and investor relations before issuance. Third, bonds are structured as simple use-of-proceeds instruments compatible with project cash flows. Fourth, securities are publicly offered, settled through the central securities depository and listed on a transparent venue. Fifth, successful issues create demonstration effects: investors learn corporate credit, intermediaries learn underwriting, and private issuers become more likely to use the market. The developmental target is not maximum issuance; it is credible, sequenced issuance that builds trust.

Moldova: SOE and capital-market constraints

The previous research (Lupusor and Stratan, 2024) documented a paradox in Moldova. SOEs and joint-stock companies with majority state participation controlled about 11.7 percent of corporate assets in 2022, but generated only around 2 percent of corporate sales and 0.7 percent of corporate profits, while holding about 9.9 percent of corporate debt. Profitability and liquidity were generally weaker than in the private sector, although solvency indicators showed that not all SOEs were distressed. This distinction matters: the obstacle is not only debt capacity, but the low efficiency with which public assets are converted into revenue, profit and investable cash flow.

The same analysis identified a smaller group of SOEs with stronger balance sheets and lower leverage that could be considered as potential frontrunners after updated due diligence. They include

Moldtelecom, Energocom, RED Nord, Barza Alba, Tracom, Arena Nationala, Loteria Nationala a Moldovei and, subject to profitability improvement, Franzeluta. Their indicative theoretical bond-issuance potential based on 2022 balance-sheet constraints was about MDL 5.1 billion. This figure should not be treated as an issuance target. It is a scale indicator showing that SOEs could materially expand the supply of domestic securities if issuance is phased and backed by strong governance.

Table 1. Potential frontrunner SOEs for corporate bond issuance in Moldova

SOE	Equity, MDL mln	Leverage	ROA	Current liquidity	Indicative issuance potential, MDL mln
Barza Alba	345.5	0.11	2.08%	10.7	150.0
Energocom	8,036.9	0.34	1.17%	14.5	1,900.0
Loteria Nationala a Moldovei	211.5	0.28	57.7%	3.4	63.0
Moldtelecom	4,250.6	0.19	0.76%	5.2	1,600.0
RED Nord	2,637.7	0.12	2.32%	8.6	1,100.0
Tracom	67.7	0.01	2.53%	78.6	33.4
Arena Nationala	834.5	0.38	1.32%	2.6	161.4
Franzeluta	249.0	0.21	-6.09%	4.9	92.3

Source: author estimations

The capital-market constraint is equally important. Moldova has one of the lowest financial-market-depth indicators in the region and remains characterized by limited instruments, weak secondary trading, few issuers and a modest non-bank institutional investor base. However, the context has improved recently. The National Capital Market Development Strategy for 2025-2030 now explicitly targets diversified instruments, long-term corporate finance, investor confidence, financial education and instruments such as green, mortgage and project bonds. At the same time, the domestic corporate-bond market has practical precedent through listed MAIB bond issues. Moldova therefore no longer needs to prove that corporate bonds can exist; it must expand the issuer base beyond banks and ensure that the first SOE issuers set a high-quality standard.

International best practices for SOE bond issuance

International experience shows that successful SOE bond issuance is rarely an isolated transaction. It is normally embedded in a financing architecture: clear ownership policy, credible audit, professional boards, fiscal-risk monitoring, explicit state-support rules and predictable investor relations. The most relevant comparators for Moldova are Baltic and Central European state-controlled utilities, together with larger global strategic SOEs that show how repeated market access is organized.

Table 2. International practices relevant to Moldova

Issuer/country	Practice	Lesson for Moldova
Latvenergo, Latvia	Repeated green bond issuance listed on Nasdaq Baltic with allocation and impact reporting.	Use green labels only where eligible projects, tracking and annual reporting are credible.
Ignitis Group, Lithuania	Programme-based green bond issuance, ratings, exchange listings and investor reporting.	Start smaller but use programme logic to lower repeat transaction costs and build a curve.
Eesti Energia, Estonia	State-owned energy issuer using green and hybrid finance instruments.	Transition finance requires transparent leverage management and conservative first structures.
Temasek, Singapore	Medium-term note and commercial paper programmes backed by clear funding policy and strong ratings.	Replicate clarity of funding policy, not scale; avoid ad hoc politically driven borrowing.

Issuer/country	Practice	Lesson for Moldova
Codelco, Chile	State-owned strategic company issuing international bonds for large capital expenditure.	Large SOE debt must be integrated into fiscal-risk and ownership monitoring.
EDF, France	EMTN, green and hybrid instruments within a sustainable finance framework.	Complex instruments should follow only after plain-vanilla bonds build domestic confidence.

Source: author synthesis from issuer disclosures, exchange information, OECD/World Bank governance guidance and EBRD project materials.

Seven best-practice principles emerge. First, issuer selection must be based on commercial credit quality, not political visibility. Second, the state role must be explicit: a bond is either guaranteed, with the fiscal commitment disclosed and approved, or it is a corporate credit instrument without state guarantee. Third, proceeds should finance identifiable investment projects rather than operating losses. Fourth, the issuer should use professional intermediaries, legal counsel, auditors and, where feasible, an external rating or credit opinion. Fifth, securities should be dematerialized, settled through the central securities depository and listed on a regulated or transparent venue. Sixth, post-issuance reporting should cover financial results, covenant compliance, material events and use of proceeds. Seventh, the first issues should be conservative: domestic currency, plain-vanilla coupons, moderate maturities and simple redemption rules.

The Baltic cases are particularly relevant. They show that state-owned utilities in small European markets can use bonds to finance infrastructure and green transition when disclosure and reporting are credible. They also show that a green bond should not be used as a branding device. It must be supported by eligible projects, tracking of proceeds, external review and annual allocation or impact reporting. For Moldovan SOEs, the first objective should be a bankable project; the green label can follow only if the project and reporting systems meet recognized principles such as the ICMA Green Bond Principles.

Advantages for Moldova's SOE sector

Corporate bonds can provide five advantages for Moldovan SOEs. The first is financing diversification. SOEs currently rely on retained earnings, bank loans, budget allocations, donor funds or supplier credit. Retained earnings are limited by weak profitability and dividend extraction; bank loans may be short in maturity and collateral intensive; budget funds compete with other public priorities; and donor funds can be project-specific and slow. Bonds can mobilize domestic savings directly from households, banks, insurers, investment funds and companies. Banks remain important as arrangers, custodians, market makers and investors, but the financing ecosystem becomes broader. The second advantage is better maturity matching. Many SOEs need long-lived investment in telecommunications, electricity distribution, energy security, logistics, industrial infrastructure or production modernization. A bond can match repayment to project economics more flexibly than a short amortizing loan. For a pilot market, simple fixed or floating coupon bonds with moderate maturity are preferable; over time, successful issuers can use programme issuance, longer maturities or thematic instruments.

The third advantage is potential cost competitiveness. A transparent SOE with stable cash flows may borrow at a spread between government securities and higher-risk private corporate debt. The first issue may include novelty and transaction-cost premiums, but repeated issuance under standardized documentation can reduce costs. Even when the coupon is not lower than a bank loan, bonds may still be preferable if they lengthen maturity, reduce collateral constraints and create a public track record.

The fourth advantage is governance. To issue credibly, an SOE must disclose audited accounts, risk factors, repayment sources, related-party transactions, public-service obligations and material events.

This creates an external accountability mechanism beyond the ownership agency and line ministry. Investors become a constituency for timely reporting and disciplined cash-flow management. A reliable bond record can also strengthen preparation for future minority listing or strategic partnership.

The fifth advantage is alignment with Moldova's development and EU integration priorities. Energy, digital, transport and utility SOEs can finance projects that reduce losses, improve efficiency, increase resilience, integrate renewable energy or modernize service delivery. Green or transition bonds may attract additional investors, but only when eligible projects, external review and annual reporting are in place.

Impact on capital-market development

SOE bonds can affect Moldova's capital market through six channels. First, they increase the supply of investable instruments. A phased realization of only 10 percent of the MDL 5.1 billion indicative potential would add about MDL 510 million in new securities, a material increase for a shallow market. Second, repeated issuance can create benchmark credit spreads between government securities and private corporate debt. Investors would observe the price of quasi-sovereign but non-guaranteed corporate risk, helping private issuers price future bonds.

Third, SOE bonds can broaden the investor base. Retail investors may be attracted by familiar names, while banks, insurers and future pension or investment funds gain local-currency instruments for portfolio diversification. This requires investor education. SOE bonds must not be sold as deposits or government securities; investors must understand credit, liquidity, interest-rate and reinvestment risks. Fourth, issuance builds intermediary capacity. Arrangers, lawyers, auditors, the stock exchange, the central securities depository and the regulator all learn by processing real transactions. Larger SOE issues create incentives to invest in market infrastructure and analytical capacity.

Fifth, successful SOE issues can crowd in private issuers by demonstrating that bonds are feasible. This effect will occur only if pricing is fair. If SOEs issue at artificially low yields because investors assume an unconditional rescue, private companies may be crowded out. Therefore, guarantee status must be explicit and pricing must reflect actual risk. Sixth, SOE bonds can raise market trust. A well-prepared issue that pays coupons on time, reports regularly and communicates clearly will improve confidence. A poorly prepared issue would damage the market. Moldova's first SOE bonds should therefore be treated as public-interest transactions with standards above the legal minimum.

Procedures for SOE corporate bond issuance

A Moldovan SOE should follow a sequenced procedure. The first stage is eligibility screening. Under Moldova's capital-market framework, corporate bonds can be issued by eligible corporate forms, including joint-stock companies and limited liability companies. State enterprises that have not been corporatized are not immediate issuers. The Public Property Agency should therefore classify SOEs as immediately eligible, eligible after governance and financial improvements, or requiring corporatization and restructuring.

The second stage is pre-issuance diagnostics. The issuer should review at least three years of financial statements, accounting policies, cash-flow projections, arrears, contingent liabilities, litigation, procurement practices, tariffs, public-service obligations, environmental and social risks and project feasibility. The board should approve a bond-readiness report. Before filing any prospectus, the issuer should have audited statements, an active board, audit committee or equivalent oversight, internal controls, a risk register, transparent procurement rules and a website containing annual reports, governance information and investor contacts.

The third stage is project selection. The bond should finance a defined investment programme rather than general operating needs. The project memorandum should explain what will be financed, why it is needed, how procurement will work, how cash flows or service quality will improve, and how implementation will be reported. For green or sustainability bonds, eligible categories must be defined, proceeds tracked separately and annual allocation and impact reporting prepared.

The fourth stage is transaction structuring and approval. The issuer and arranger set currency, amount, maturity, coupon, redemption method, covenants, events of default, investor categories, guarantee status and listing venue. First issues should be domestic-currency and plain-vanilla; foreign-currency debt should be avoided unless the SOE has natural foreign-currency revenues. Approvals should involve the board, shareholder or state-owner, ownership agency, Ministry of Finance where fiscal risk is relevant, NCFM, Moldova Stock Exchange and Central Securities Depository.

Table 3. Compact roadmap for SOE bond issuance in Moldova

Stage	Main actions	Lead actors
1. Eligibility	Confirm legal form, charter authority, profitability, equity limits, prior obligations and SOE borrowing approvals.	SOE, Public Property Agency, legal counsel
2. Governance upgrade	Audit, independent board capacity, audit/risk committee, disclosure website, internal controls and investor contact.	SOE board, auditor, ownership agency
3. Project model	Define use of proceeds, procurement plan, cash-flow effects, debt-service capacity and stress scenarios.	SOE management, technical advisers, arranger
4. Documentation	Prepare prospectus, financial disclosure, risk factors, bond terms, subscription rules and guarantee statement.	Issuer, arranger, counsel, auditor
5. Approval and marketing	Submit to NCFM, coordinate with MSE/CSD, run investor education, bookbuild, price and allocate.	NCFM, MSE, CSD, arranger, issuer
6. Post-issuance	List and settle securities; publish financial reports, material events, covenant and use-of-proceeds updates.	Issuer, board, ownership agency, regulator

Source: author synthesis based on the national legislation

The fifth stage is prospectus, marketing and allocation. The prospectus must provide issuer history, ownership, governance, business model, financial statements, risk factors, project description, bond terms, taxation, subscription procedures, secondary-market trading and material contracts. SOEs should add disclosures on public-service obligations, tariff rules, state support, dividend policy, procurement rules and related-party transactions. Marketing should be educational rather than promotional, with clear warnings that corporate bonds carry credit and liquidity risk unless explicitly guaranteed.

The sixth stage is post-issuance discipline. The issuer should publish annual audited statements, interim financial updates, material-event notices, covenant compliance, coupon-payment information and use-of-proceeds reports. The ownership agency and Ministry of Finance should monitor SOE bond debt in a fiscal-risk dashboard covering outstanding debt, maturities, guarantee status, debt-service coverage, project progress, covenant breaches and refinancing needs.

Risks, safeguards and policy recommendations

The main risk is implicit-guarantee moral hazard. Investors may assume that an SOE bond is state debt even when no guarantee exists. Moldova should adopt a simple rule: SOE bonds are not state-guaranteed unless a formal guarantee is approved, disclosed and recorded under fiscal rules. Prospectuses must state the guarantee status explicitly. A second risk is that bonds finance operating

losses or postpone restructuring. Pilot bonds should finance productivity-enhancing investment or prudent refinancing, not losses. A third risk is political interference through board appointments, tariff decisions, procurement or dividend extraction. Safeguards include independent board members, transparent ownership mandates, costed public-service obligations, audited accounts and published related-party transactions.

Retail investor protection is also essential. SOE bonds may be attractive to citizens because the issuer is familiar, but familiarity can create false confidence. Subscription documents should explain that bonds are investments, prices may fluctuate, secondary-market liquidity may be limited and repayment depends on issuer capacity unless explicitly guaranteed. For green bonds, Moldova should prevent greenwashing through external review, eligible project categories, tracking of proceeds and annual impact reporting.

In the short term, Moldova should launch a high-standard pilot with one or two SOEs selected through transparent criteria: eligible corporate form, audited accounts, moderate leverage, positive cash-flow outlook, credible project and readiness to disclose. The 2022 financial analysis should be updated with 2023-2025 audited data. A common bond-readiness checklist should be approved by the Public Property Agency, Ministry of Finance, NCFM and Moldova Stock Exchange. The first bond should be small to moderate in size, domestic-currency, listed, dematerialized, without ambiguous state guarantee and supported by investor education.

In the medium term, Moldova should adopt an SOE debt-management policy covering approval thresholds, guarantees, maturity limits, debt-service ratios and reporting obligations. Successful pilot SOEs can issue under programmes with multiple series, creating a domestic quasi-corporate curve. Institutional demand should be developed through insurance, pension and investment-fund reforms, while secondary-market liquidity can be supported by transparent pricing and lower transaction costs. Green or transition bonds should be introduced only for issuers with eligible investment pipelines and reporting systems.

In the long term, suitable state enterprises should be corporatized into joint-stock companies or limited liability companies where consistent with ownership policy. Disclosure, prospectus and market-abuse rules should converge progressively with EU standards. A reliable SOE bond record can prepare some companies for minority listings or privatization, while fiscal-risk reporting should integrate all SOE bonds and guarantees. Regional connectivity with Romanian and EU capital-market infrastructure should be explored once domestic foundations are stronger.

Conclusions

SOE corporate bonds can become a catalyst for Moldova's capital-market development, but only under demanding conditions. The opportunity is real: a subset of Moldovan SOEs has sufficient balance-sheet scale to produce a meaningful increase in domestic instruments, and the estimated indicative potential of about MDL 5.1 billion shows that public companies can move the market if issuance is phased. The timing is also favorable because the 2025-2030 capital-market strategy prioritizes diversified instruments and long-term corporate finance, while practical domestic bond precedent already exists.

The risks are equally real. Weak governance, politically influenced management, unfunded public-service obligations, ambiguous state guarantees, mis-selling to retail investors and greenwashing could damage the very market the policy aims to develop. The paper's conclusion is therefore conditional. SOE bonds should not be used as off-budget public debt or as a substitute for restructuring. They should finance credible investments, be priced according to disclosed risk, be listed and settled transparently, and be monitored through both market and fiscal-risk channels.

If these conditions are met, SOE bonds can serve three reform objectives simultaneously. They can finance modernization of strategic SOEs, expose those SOEs to stronger disclosure and market discipline, and expand Moldova's capital market through new instruments, benchmarks, investors and intermediary capacity. The first transactions will be decisive. A disciplined pilot can build trust

and crowd in private issuers; a weak transaction can set the market back. Moldova should therefore proceed, but proceed selectively, transparently and with standards above the legal minimum.

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INTEGRAL EVALUATION OF ECONOMIC COMPONENT OF SPATIAL DEVELOPMENT DIVERSIFICATION IN UKRAINIAN REGIONS

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Abstract: *Diversification is generally considered to reduce the risks of undesirable developments, particularly in the face of external challenges and shocks. Diversification of spatial development is a complex phenomenon that encompasses various spheres of the socio-economic development of a country's regions. This study is devoted to the quantitative measurement of the diversification of the economic component of spatial development at the regional level. The aim of the article is to assess changes in the diversification of spatial development in the regions of Ukraine caused by military aggression.*

The study employs methods of multivariate analysis, namely factor analysis (principal component analysis with rotation), the method of information space aggregation (integral indicator), and the Herfindahl–Hirschman Index. The integral assessment of the level of diversification of spatial development in Ukraine's regions is carried out based on components of the economic dimension, using indicators that describe budget structure, export activity, sectoral structure, capital investment, employment, business environment, and innovation, which were applied to analyze the geographical and sectoral dimensions of economic diversification.

The integral assessment of diversification of spatial development in the regions of Ukraine made it possible to identify key diversification factors: budgetary, sectoral, tax, employment, scientific, investment and innovation, economic activity, and innovation-related factors, the composition of which changed during wartime compared to the pre-war period. The most diversified regions in terms of the economic component in 2021 and 2023 were identified, and three groups of regions of Ukraine were distinguished according to the level of diversification based on the value of the calculated integral indicator. During the analyzed period, changes in the values of the integral diversification indicator occurred in all regions; however, it was found that the overall ranking of regions remained largely stable.

The application of the developed approach to assessing the level of diversification of spatial development in the regions of Ukraine will make it possible to determine the most influential diversification factors, identify disparities in diversification across different components and dimensions of spatial development, and ensure a faster response to emerging threats, in particular by identifying directions for adjusting regional-level strategies and programs.

Key words: *diversification, spatial development, integral indicator, factor analysis, region.*

JEL: C02; R12

Introduction

Diversification is generally considered to reduce the risks of undesirable developments, particularly in the face of external challenges and shocks. Diversification of spatial development is a complex phenomenon that encompasses various spheres of the socio-economic development of a country's regions.

Diversification of spatial development of regions implies the development of territories within a state, taking into account their specific natural, economic, cultural, and social characteristics. It contributes

to the balanced development of all regions of the country, the reduction of territorial disparities and inequalities, as well as the fuller realization of each territory's potential.

In scientific research, various approaches [1–5] are distinguished for defining spatial development and its role in shaping socio-economic processes across different types of territories. Within the framework of this study, the approach to interpreting the diversification of spatial development of regions proposed by Yu. Ivanov, O. Ivanova is applied, viewing it as a process of ensuring stable socio-economic development of territorial units, creating conditions for their self-sufficiency and self-development, improving the efficiency of the use of regional-level resources, eliminating regional disparities and dependence on the center, and reducing budgetary and financial risks at the meso level [6].

An integral assessment of the diversification of spatial development of the regions of Ukraine is a necessary stage of the empirical analysis of economic diversification in the country's spatial development. It involves the application of an evaluation methodology that takes into account the interrelationships between socio-economic indicators, avoids their duplication, and provides a comprehensive view of the results.

The aim of this study is to assess changes in the level of diversification of spatial development in Ukraine's regions caused by military aggression.

Only a limited number of studies are devoted to measuring the level of economic diversification as a whole. The Herfindahl–Hirschman Index and its modifications are most commonly used. The greatest attention is paid to diversification in the context of international trade.

The United Nations Conference on Trade and Development (UNCTAD) measures indices that are inverse to diversification – namely, concentration indices of commodity exports and imports for each country, based on the share of a specific commodity (or group of commodities) in the total volume of a country's exports (imports), as well as market concentration indices for particular goods relative to their countries of origin. In this context, the Theil index [7], the Herfindahl–Hirschman Index [8], and the Gini coefficient are used.

The diversification of public revenues is assessed based on the shares of excise taxes, corporate income tax, taxes on goods and services, as well as total revenues as a percentage of GDP [9].

The most generalized approach to assessing the level of diversification is proposed in an experimental project [10], which introduces the Global Economic Diversification Index (EDI) for countries worldwide. The index covers three areas: output, trade (international), and revenues (public). While specific types of economic activity are not examined in detail, the output sub-index distinguishes agriculture, extractive industries, manufacturing, and medium- and high-technology industries. A distinctive feature of the project is its focus on analyzing resource dependence of economies; therefore, resource rents and exports of hydrocarbons and fuels are also included in the analysis.

Trade diversification is assessed using gross export and import volumes, the share of exports of manufactured goods and medium- and high-technology industries, as well as export and import concentration indices calculated by the World Bank and UNCTAD [10]. The primary data for evaluating all components are sourced from the World Bank, UNCTAD, and the International Monetary Fund, which ensures consistency in measurement.

Unlike most other studies, the diversification index is constructed based on the identification of principal components, which makes it possible to combine indicators of different origins. At the same time, the assessment results for different years are not directly comparable, since the weighting coefficients for each year (taking into account their dynamics and the increasing number of countries covered during 2019–2022) differ; however, the relative ranking of countries is preserved.

The Principal Components Analysis, a standard dimensionality-reduction technique, was used to generate the results. The strategy for applying PCA to the detailed indicators relied on two steps. The first was to use PCA to produce the three sub-indices: output, trade, and revenue. The second was then to aggregate the three subindices into an overall EDI by taking the arithmetic (simple) mean [10].

Among the advantages of the proposed index for assessing the diversification of a country's spatial development is its coverage not only of the production and external economic spheres, but also of the fiscal (budgetary) domain. In addition, the approach involves constructing a composite indicator, which makes it possible to rank objects and simplifies analysis. The use of principal components as estimates for sub-indices can also be applied, although it requires more thorough justification. At the same time, the principal component method can be used to identify the most influential indicators for constructing an assessment of the level of diversification. These advantages determined the choice to apply the principal component method and linear aggregation to assess the economic component of the diversification of spatial development in the regions of Ukraine.

Basic content

Figure 1 presents an algorithmic model for calculating the integral indicator of diversification of spatial development in the regions of Ukraine, which consists of three steps. The initial data for conducting the integral assessment are partial indicators of diversification by components and subcomponents. At this stage of the study, the economic component was considered.

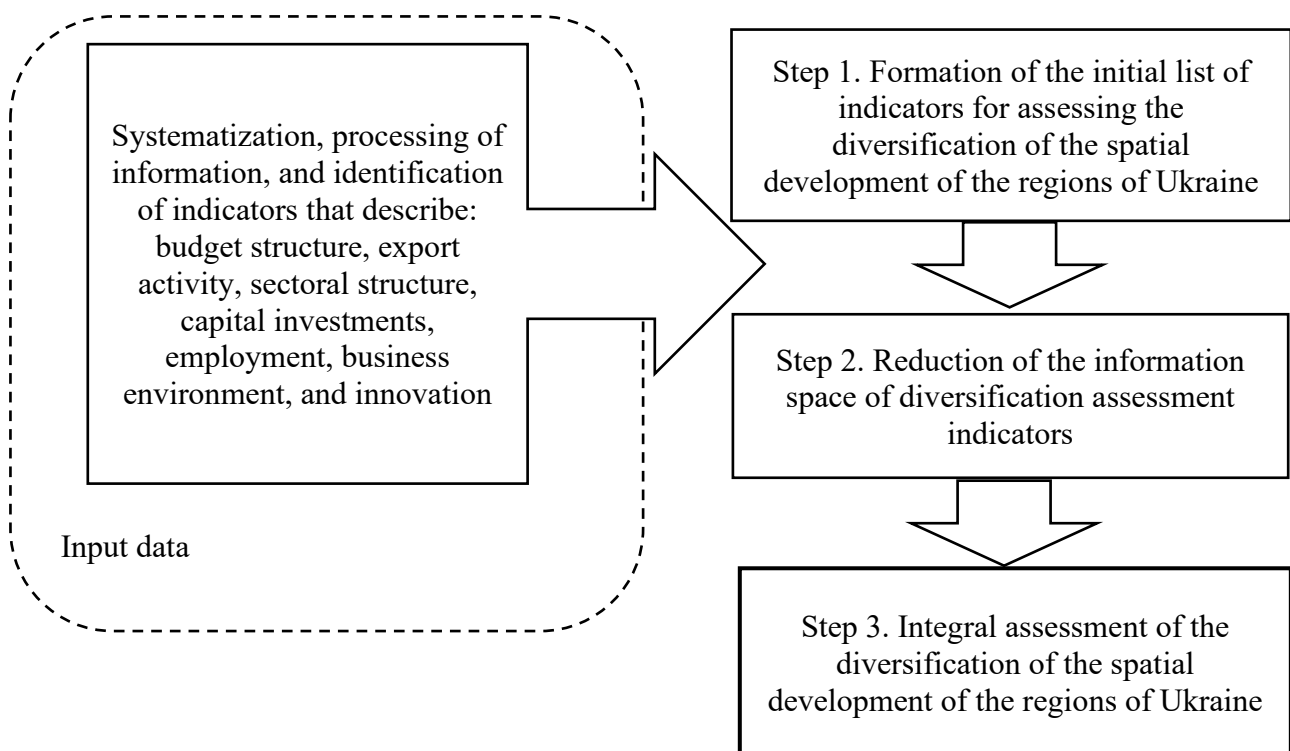


Figure 1. Algorithmic model of the integral assessment of the diversification of the spatial development of the regions of Ukraine

Source: compiled by the authors

Step 1. *Formation of the initial list of indicators for assessing the diversification of the spatial development of the regions of Ukraine.* Based on a synthesis of the scientific literature and the developments of international organizations [2, 4, 6-8, 10], an initial list of indicators that can potentially characterize the level of diversification of spatial development was formed. To construct the information and analytical framework of the study, a set of indicators describing the budget structure, export activity, sectoral structure, capital investments, employment, business environment, and innovation was identified. These indicators were used to analyze the geographical and sectoral dimensions of economic diversification according to data from [11,12].

For further calculations, data processing, systematization, and selection of indicators for analysis were carried out. The list and notation of the indicators for assessing the diversification of spatial development, initially selected for calculating the integral index, are presented in Table 1.

Table 1. Indicators for assessing the diversification of the spatial development of Ukraine's regions by the economic component

№	Indicator name	Indicator notation
1	Herfindahl–Hirschman Index of the structure of local budget revenues	HHI_budg_rev
2	Herfindahl–Hirschman Index of the structure of tax revenues to local budgets	HHI_tax_rev
3	Total revenues per 1,000 persons, thsd. UAH	Budg_rev_pc
4	Total own revenues per capita, UAH	SBudg_rev_pc
5	Herfindahl–Hirschman Index by export commodity groups	HHI_Exp
6	Herfindahl–Hirschman Index of the distribution of sales volumes across 27 types of economic activity	HHI_OR_27
7	Share of the manufacturing industry in total sales volume	ShMan
8	Herfindahl–Hirschman Index based on the shares of types of economic activity in the region's gross value added	HHI_VA
9	Economic productivity, %	VA_p_Output
10	Labor productivity of employed persons	Prod_emp
11	Herfindahl–Hirschman Index of capital investments by types of economic activity	HHI_inv
12	Capital investment intensity, UAH per 1,000 UAH of gross value added	Inv_intens
13	Share of large enterprises in total employment, %	LE_emp
14	Herfindahl–Hirschman Index by the number of employed persons across 16 types of economic activity	HHI_emp_18
15	Informally employed population as a percentage of the total employed population aged 15–70 in the region	Inform_emp
16	Herfindahl–Hirschman Index of the distribution of the number of business entities across 27 types of economic activity	HHI_En_27
17	Share of large enterprises in the total number of active enterprises	LE_sh
18	Share of small enterprises in the total number of active enterprises	SE_sh
19	Number of applications for patents for inventions, utility models, and industrial designs per 100,000 population	IPZ
20	Number of registered intellectual property titles per 100,000 population	IPR
21	Share of innovation-active enterprises in the total number of enterprises in the region, %	InAE
22	Innovation expenditures as a percentage of the region's capital investments, %	InVytr
23	Number of elements of the innovation infrastructure	In_infr

Source: compiled by the authors

In accordance with the purpose of the study, 2021 was chosen as the base year. For the current assessment of the diversification of the spatial development of the regions of Ukraine, input data for 2023 were used as the most complete. Thus, the initial information space included two sets of available data. It should be noted that, due to confidentiality reasons as well as the unreliability of data for the Donetsk and Luhansk regions, certain indicators were not calculated, which subsequently led to the exclusion of these regions from the overall diversification ranking. This also applies to two additional regions, as will be shown below.

Step 2. Reduction of the information space of diversification assessment indicators. The reduction of the list of input indicators was carried out using factor analysis. Since the indicators used to assess diversification have different units of measurement, a standardization procedure was applied in the

study. The use of the principal component method with rotation made it possible to identify the most influential factors among the initially selected indicators.

Unlike study [10], in which, according to the division into three components, all indicators of the respective component were included in the factors regardless of their factor loadings, in our study only statistically significant indicators were included in the factors. This made it possible to identify specific directions of diversification, which can subsequently serve to determine priorities. The application of the selected methodological tools allowed for a reduction of the initial data space and the identification of the following most significant factors for assessing the diversification of the spatial development of the regions of Ukraine in 2021:

$$\begin{aligned} F1 (\text{budgetary}) &= -0,929828 * HHI\_budg\_rev - 0,722743 * HHI\_tax\_rev + \\ &+ 0,829546 * Budg\_rev\_pc + 0,909474 * SBudg\_rev\_pc - 0,729228 * HHI\_En\_27; \\ F2 (\text{sectoral}) &= 0,759573 * HHI\_Exp + 0,804813 * ShMan - 0,904363 * VA\_p\_Output + \\ &+ 0,893535 * LE\_emp + 0,779614 * LE\_sh; \\ F3 (\text{scientific}) &= 0,865267 * IPZ + 0,859689 * IPR; \\ F4 (\text{investment-innovation}) &= 0,744431 * Inv\_intens - 0,847315 * SE\_sh; \\ F5 (\text{economic activity}) &= 0,811522 * HHI\_VA + 0,784770 * HHI\_emp; \\ F6 (\text{innovative}) &= 0,705338 * InAE. \end{aligned}$$

As a result of reducing the information space of diversification assessment indicators by regions for 2023, as in the base year 2021, the following factors were obtained using factor analysis:

$$\begin{aligned} F1 (\text{budgetary}) &= 0,857 * Budg\_rev + 0,8819 * SBudg\_rev\_pc - 0,8149 * HHI\_En\_27; \\ F2 (\text{sectoral}) &= -0,821 * HHI\_OR\_27 + 0,8114 * ShMan + 0,893 * HHI\_inv; \\ F3 (\text{tax}) &= 0,8649 * HHI\_budg\_rev + 0,9526 * HHI\_tax\_rev; \\ F4 (\text{employment}) &= 0,7545 * Prod\_emp + 0,7737 * LE\_emp + 0,9218 * LE\_sh; \\ F5 (\text{innovation expenditure}) &= 0,9114 * InVyr; \\ F6 (\text{innovation infrastructure}) &= 0,9275 * In\_infr. \end{aligned}$$

Thus, in 2023, compared to 2021, changes occurred in the composition of factors identified for assessing the diversification of the spatial development of Ukraine's regions. There was a reduction in the number of indicators reflecting the budgetary and sectoral structure. However, a tax-related factor, an employment factor, as well as separate factors of innovation expenditures and innovation infrastructure were identified. This indicates the dynamic nature of the environment, the need for rapid adaptation to the challenges of regional development in Ukraine due to the emergence of new threats, as well as the necessity to adjust strategies or make appropriate managerial decisions.

Step 3. *Integral assessment of the diversification of the spatial development of the regions of Ukraine.*

At the final stage of the study, the reduction of the information space is carried out using an integral indicator that combines the factors obtained in the second step of the algorithmic model for assessing the diversification of spatial development of Ukraine's regions. This indicator makes it possible to quantitatively measure an object described by a large number of variables by aggregating them into a single composite measure, and also enables the ranking of the objects under study.

To calculate the integral indicator of diversification of spatial development of the regions of Ukraine, an additive model is used:

$$ID (\text{Integral indicator of diversification}) = (F_1 + \dots + F_n) / n, \quad (1)$$

($F_1 \dots F_n$) – values of the factors;
 n – number of factors.

The justification for using the simple average lies in the fact that it is the most transparent approach, while there are no a priori grounds to assume that any of the selected factors is more important for the overall measurement of economic diversification than others. Table 2 presents the calculated values of the integral indicator of diversification by regions in 2021. The ranking of Ukraine's regions

is based on the ID, assuming that higher values of the integral indicator correspond to more diversified regions.

Table 2. Integral indicator of diversification for the regions of Ukraine, 2021

Region	Factors						ID	Region's rank by ID
	F1	F2	F3	F4	F5	F6		
Vinnitsia	-0,40	0,38	0,11	0,29	0,99	1,74	0,52	3
Volyn	x	x	x	x	x	x	x	x
Dnipropetrovsk	1,30	1,41	0,46	-0,43	0,97	0,69	0,73	2
Donetsk	-1,20	2,95	-1,36	0,45	-0,07	-1,24	-0,08	12
Zhytomyr	0,02	-0,81	-0,46	0,36	-0,80	-1,22	-0,48	19
Zakarpattia	x	x	x	x	x	x	x	x
Zaporizhzhia	-0,03	1,83	1,67	-1,00	-0,70	-0,93	0,14	8
Ivano-Frankivsk	-0,85	0,15	0,40	-1,49	-0,25	0,29	-0,29	16
Kyiv	1,53	0,20	-0,26	1,09	-1,27	0,46	0,29	5
Kirovohrad	0,70	-0,84	-0,37	-0,49	0,96	-0,80	-0,14	14
Luhansk	-2,04	-0,49	-0,67	0,94	-0,45	-1,16	-0,65	21
Lviv	0,70	-0,41	-0,51	-0,08	-1,93	0,21	-0,34	17
Mykolaiv	0,07	0,46	-0,62	-1,97	0,16	1,33	-0,10	13
Odesa	0,97	-0,37	-0,78	-1,25	-1,22	0,58	-0,34	17
Poltava	1,55	-0,06	0,68	0,45	2,15	-1,80	0,49	4
Rivne	-1,20	-0,32	-0,02	-0,06	-0,40	0,77	-0,20	15
Sumy	-0,21	-0,31	0,18	1,63	-0,50	0,00	0,13	9
Ternopil	-1,18	-0,13	2,07	1,37	0,81	1,74	0,78	1
Kharkiv	0,66	-0,72	2,40	0,16	-1,30	-0,78	0,07	10
Kherson	-0,33	-0,88	-0,22	-1,02	1,23	-0,91	-0,36	18
Khmelnyskyi	-0,36	-0,22	-0,60	0,64	0,51	0,20	0,03	11
Cherkasy	0,45	0,36	-0,39	0,66	-0,04	0,28	0,22	7
Chernivtsi	-1,18	-1,63	-0,03	-1,29	0,45	-0,27	-0,66	20
Chernihiv	1,02	-0,54	-1,67	1,04	0,71	0,82	0,23	6

Note. Regions marked with "x" were not included in the calculations due to a lack of data. The same applies to the following tables

Source: compiled by the authors

Further, to examine the diversification of the regions of Ukraine over time, the integral indicator of diversification for the regions in 2023 was calculated (Table 3).

Table 3. Integral indicator of diversification for the regions of Ukraine, 2023

Region	Factors						ID	Region's rank by ID
	F1	F2	F3	F4	F5	F6		
1	2	3	4	5	6	7	8	9
Vinnitsia	x	x	x	x	x	x	x	x
Volyn	-1,14	-1,38	1,44	1,66	-0,18	-0,42	-0,005	10
Dnipropetrovsk	1,40	0,88	-0,35	1,75	0,35	-0,02	0,67	1
Donetsk	x	x	x	x	x	x	x	x
Zhytomyr	-0,30	1,03	1,50	-0,57	-0,74	0,61	0,25	4
Zakarpattia	x	x	x	x	x	x	x	x
Zaporizhzhia	x	x	x	x	x	x	x	x

Region	Factors						ID	Region's rank by ID
	F1	F2	F3	F4	F5	F6		
1	2	3	4	5	6	7	8	9
Ivano-Frankivsk	-0,48	0,42	-0,78	-0,94	-0,28	0,26	-0,30	12
Kyiv	0,51	-0,42	-0,62	1,30	-0,99	0,42	0,03	9
Kirovohrad	-0,16	0,18	-1,19	-0,62	0,69	-0,78	-0,31	13
Luhansk	x	x	x	x	x	x	x	x
Lviv	0,32	-0,77	0,52	0,55	-0,45	2,39	0,43	3
Mykolaiv	2,27	-0,86	1,63	-1,18	0,19	-1,42	0,10	7
Odesa	0,63	-1,97	-1,04	-0,69	-0,36	-0,32	-0,63	14
Poltava	0,53	1,04	-1,49	0,95	-0,63	-0,89	-0,08	11
Rivne	x	x	x	x	x	x	x	x
Sumy	-0,31	1,19	0,43	-0,91	-0,70	0,66	0,06	8
Ternopil	-0,64	0,52	0,25	0,56	1,21	-0,65	0,21	5
Kharkiv	0,59	0,12	-0,45	-0,75	2,20	1,73	0,57	2
Kherson	x	x	x	x	x	x	x	x
Khmelnyskyi	-1,23	0,33	0,75	0,31	1,63	-0,88	0,15	6
Cherkasy	x	x	x	x	x	x	x	x
Chernivtsi	-1,65	-1,32	-0,90	-0,72	-0,38	-0,10	-0,85	15
Chernihiv	-0,31	1,01	0,30	-0,70	-1,55	-0,59	-0,31	13

Source: authors' calculations

Figure 2 presents the distribution of the regions of Ukraine by the integral indicator of diversification (ID) in 2021 and 2023 for better visualization of the analysis.

By systematizing the results of the study, three groups of regions of Ukraine were identified according to the level of diversification, which are presented in Table 4.

Table 4. Distribution of the regions of Ukraine by the integral indicator of diversification over time

Level of regional diversification	2021	2023
The highest level of regional diversification (1st–5th place in the ID ranking)	Ternopil, Dnipropetrovsk, Vinnytsia*, Poltava, Kyiv	Dnipropetrovsk, Kharkiv, Lviv, Zhytomyr, Ternopil
Medium level of regional diversification (6th–10th place in the ID ranking)	Chernihiv, Cherkasy*, Zaporizhzhia*, Sumy, Kharkiv	Khmelnyskyi, Mykolaiv, Sumy, Kyiv, Volyn*
Low level of regional diversification (below 10th place in the ID ranking)	Khmelnyskyi, Donetsk*, Mykolaiv, Kirovohrad, Rivne*, Ivano-Frankivsk, Lviv, Odesa, Kherson*, Zhytomyr, Chernivtsi, Luhansk*	Poltava, Ivano-Frankivsk, Kirovohrad, Odesa, Chernihiv, Chernivtsi

Source: compiled by the authors

Note. * — the region is absent from the 2023 ranking due to a lack of data

Thus, in 2023, the highest level of diversification was observed in Dnipropetrovsk Region, while in 2021 it was in Ternopil Region.

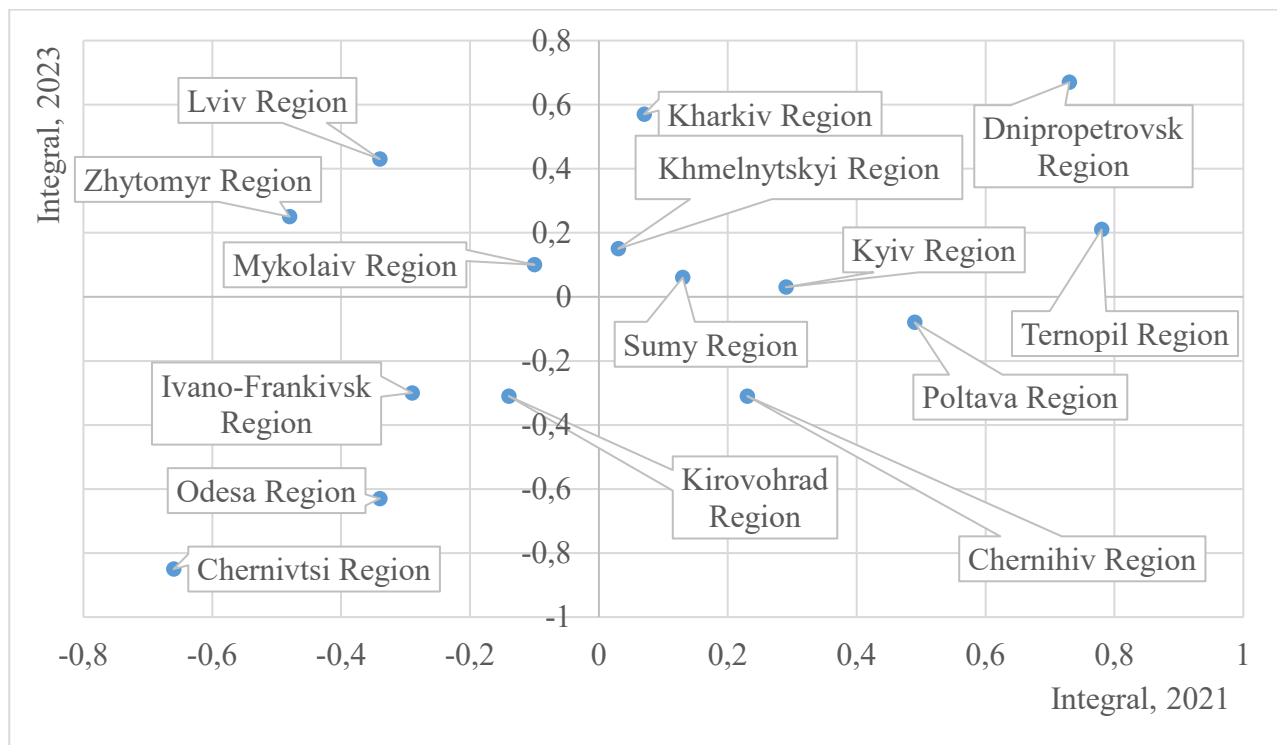


Figure 2. Distribution of the regions of Ukraine by the integral indicator of diversification in 2021 and 2023

Source: calculated and compiled by the authors

Conclusions

In 2023, compared to 2021, the level of diversification in most regions changed. In particular, it improved in the Kharkiv, Lviv, Dnipropetrovsk, and Zhytomyr regions, while it deteriorated in the Ternopil, Kyiv, and Poltava regions. These changes are partly associated with modifications in the structure of the factor space, as well as with the absence of data for certain regions, which led to their exclusion from the analysis.

However, overall, it can be argued that the ranking of regions by the level of diversification of spatial development has remained largely unchanged. This indicates insufficient attention paid to diversification issues in regional development strategies and plans. This, in turn, potentially creates risks to sustainable development not only during wartime and not only for frontline regions, but also in the period of post-war recovery.

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IMPLEMENTATION OF DUAL EDUCATION IN HIGHER EDUCATION INSTITUTIONS IN THE REPUBLIC OF MOLDOVA

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Abstract: *The purpose of the research is to analyze the institutional and legislative framework of dual education, identify the main benefits of this educational model, and evaluate its role in increasing graduates' employability and strengthening cooperation between universities and the business sector. The article examines the implementation and development of dual higher education in the Republic of Moldova as a modern mechanism for aligning university studies with labor market requirements.*

Methodology used is based on qualitative, documentary, comparative, and analytical methods used to examine analysis of official reports, legislative documents, methodological guides, and materials developed within the European project COOPERA – "Integrating Dual Higher Education in Moldova and Ukraine". By analyzing official statistics and the experiences of institutions participating in the pilot projects, the study incorporates aspects of empirical research and case study analysis. Three Moldovan universities—the Academy of Economic Studies of Moldova (ASEM), the Technical University of Moldova (UTM), and the Free International University of Moldova (ULIM)—are the focus of special attention regarding the pilot implementation of dual higher education (Academy of Economic Studies of Moldova, 2021). The process of implementing and developing dual higher education inside higher education institutions in the Republic of Moldova is the subject of this article's research.

The findings reveal that the successful implementation of dual vocational education since 2014 created favorable conditions for extending the model to higher education institutions beginning with 2022. Statistical data demonstrate a high employability rate among graduates of dual programs and increased interest from employers in participating in the educational process. The study also emphasizes how dual higher education helps students gain practical skills, makes it easier for them to enter the workforce, and advances the modernization of the country's educational system.

According to the article's conclusion, dual higher education is a strategic path for the Republic of Moldova that may enhance the standard of higher education and promote sustainable economic growth by fostering closer ties between universities and businesses.

Keywords: *Dual education, higher education, labor market, university-business partnership, Republic of Moldova*

JEL: I21, I23, J24, O15

Introduction

During the last decade, the Republic of Moldova has experienced significant transformations in the economic, social, educational, and institutional environment, generated both by globalization processes and by the country's European integration aspirations. New demands on the caliber of professional training and the competences of university graduates have been imposed by the modernization of the national economy, digitalization, technological advancement, and the growing competitiveness of the labor market. In these circumstances, the higher education system has emerged as one of the major determinants of the nation's sustainable economic growth and the development of human capital.

"The dual education model is increasingly recognized at the European level as an effective mechanism for aligning educational systems with labor market requirements. Based on the combination of theoretical instruction and practical training within companies, dual education contributes to the development of professional competencies, facilitates graduates' transition to employment, and strengthens cooperation between universities and the business sector. The German

dual education system is often considered a reference model due to its high level of employability and strong institutional partnerships between educational institutions and employers." (Călugăreanu, 2019).

The relevance of the research topic is determined by the increasing necessity to adapt higher education to the real demands of the labor market. Employers are no longer focused exclusively on theoretical knowledge, but increasingly require graduates with practical experience, professional adaptability, and applied competencies. In the Republic of Moldova, one of the major vulnerabilities of the traditional higher education system remains the disproportion between theoretical preparation and practical training, which often complicates graduates' integration into professional activity. Similar conclusions are emphasized in studies dedicated to the implementation of dual higher education within the Erasmus+ COOPERA project.

"The motivation for choosing this topic is closely related to the recent implementation of dual higher education in Moldova, the limited number of scientific studies dedicated to this educational model at university level and the topic is examined within the author's doctoral research on dual higher education in the Republic of Moldova. Although dual education was introduced in vocational technical education beginning with 2014, its positive results regarding employability, employer involvement, and workforce qualification encouraged the extension of this model to higher education institutions. Starting with the academic year 2022–2023, the dual higher education model began to be piloted within three universities from the Republic of Moldova: the Academy of Economic Studies of Moldova (ASEM), the Technical University of Moldova (UTM), and the Free International University of Moldova (ULIM)". (Solcan et al., 2024).

The purpose of this research is to analyze the implementation process of dual higher education in the Republic of Moldova, identify its opportunities and challenges, and evaluate its contribution to increasing graduates' competitiveness and strengthening university-business cooperation. The research methodology is based on qualitative analysis of scientific literature, legislative documents, institutional reports, methodological guides, and official materials developed within the COOPERA project. Additionally, comparative and analytical approaches were used to examine the evolution of dual education and its adaptation to the Moldovan higher education system.

The current stage of research demonstrates that dual higher education is still in an early development phase in the Republic of Moldova, but existing studies and pilot initiatives indicate significant potential for improving educational quality, increasing employability, and modernizing the relationship between universities and the business sector.

Basic content

Dual higher education represents an efficient model of professional training based on close cooperation between the university, the student, and the business sector. By combining theoretical preparation with practical experience carried out directly within companies, this system contributes to the development of competitive specialists capable of responding quickly and effectively to labor market demands. At the same time, dual education facilitates the professional integration of graduates and reduces the gap between the competencies acquired during the educational process and the actual needs of employers (Covaș & Stihi, 2023,).

According to the data presented within the COOPERA project and the methodological materials developed for the implementation of dual education, during the period 2016–2020 approximately 5,300 dual training places were subsidized from the state budget, while more than 4,100 apprentices were enrolled in over 45 occupations and specialties provided by around 35 vocational and technical education institutions across the country. The average employability rate of graduates from these programs reached approximately 70%, of which nearly 38% remained employed within partner companies. These results confirm that dual education significantly contributes to the integration of young people into the labor market and to reducing the shortage of qualified workforce (COOPERA Project, 2021).

The success achieved within vocational technical education represented a determining factor for the extension of the dual system to the higher education level as well. Thus, "the year 2022 marks the beginning of the implementation of dual higher education in the Republic of Moldova through the launch of a pilot program carried out within the European project COOPERA – "Integrating Dual Higher Education in Moldova and Ukraine", coordinated by the Academy of Economic Studies of Moldova. The project was implemented during the period 2021–2024, with a total budget of EUR 967,200, aiming to develop a flexible and functional model of dual higher education in the Republic of Moldova and Ukraine" (COOPERA Project handbook, 2021).

The pilot program was implemented in three higher education institutions:

1. Academy of Economic Studies of Moldova (ASEM),
2. Technical University of Moldova (UTM),
3. Free International University of Moldova (ULIM).

Within ASEM, the bachelor's degree programs "Business and Administration" and "Applied Informatics" were launched, with a study duration of 3 years and 180 ECTS credits.

At UTM, the dual education model was introduced for the specialties "Automation and Informatics" and "Robotics and Mechatronics", programs with a duration of 4 years and 240 ECTS credits.

At the same time, ULIM implemented the dual system within the master's program "Diplomacy, Security, Business and Communication", with a duration of 2 years and 120 ECTS credits.

The results achieved within the pilot programs implemented starting with the 2022–2023 academic year demonstrate both the growing interest of the business environment in direct participation in the professional training process and the efficiency of this model in developing students' practical competencies.

A relevant example is the dual bachelor's degree program "Business and Administration" within the Academy of Economic Studies of Moldova, where in 2025 a total of 14 students were involved in practical training activities carried out within important partner companies such as "Efes Vitanta Moldova Brewery" JSC, "Moldtelecom" JSC, "Moldcell" JSC, "MAIB" Commercial Bank JSC, and "MGF Engros" LLC. The diversity of the companies involved confirms the expansion of cooperation between higher education institutions and the private sector, as well as the strengthening of the relationship between the academic environment and the real economy. The table below presents the figures described above.

Table 1. Distribution of Students and Partner Companies.

Partner Company	Number of Students
Efes Vitanta Moldova Brewery JSC	6
Moldtelecom JSC	4
Moldcell JSC	2
MAIB Commercial Bank JSC	1
MGF Engros LLC	1

Source: compiled by the author based on ASEM internal data for the 2024–2025 academic year.

The Ministry of Education and Research of the Republic of Moldova expanded the use of this type of study for the 2025–2026 academic year due to the success of the initial dual university programs. Therefore, the extension process targets other higher education institutions in addition to the universities that initially took part in the pilot project: the Academy of Economic Studies of Moldova, the Technical University of Moldova, and the Free International University of Moldova. According to the Ministry of Education and Research of the Republic of Moldova (2024), the dual higher education model is being expanded to additional universities beginning with the 2025–2026 academic year. This decision reflects the growing interest of public authorities in developing a practice-oriented educational system aligned with the current needs of the labor market.

Another important aspect of the expansion process is the diversification of dual study programs. While in the initial stage dual higher education was mainly focused on the fields of business, informatics, and engineering, for the 2025–2026 academic year its extension is aimed toward priority fields for the national economy, such as information technologies, pedagogy, advanced engineering, public administration, and other interdisciplinary specialties. This trend demonstrates the flexibility of the dual education model and its capacity to adapt to contemporary economic and technological changes.

As presented above, currently, the dual higher education system is implemented or piloted within five universities in the Republic of Moldova, with the following officially identified specialties/study programs, see table 2:

Table 2. Dual Higher Education Study Programs Implemented within Universities of the Republic of Moldova

University	Dual Study Specialties / Programs	Level
Academy of Economic Studies of Moldova	Business and Administration; Applied Informatics; Marketing and Logistics; Finance and Accounting	Bachelor's Degree
Technical University of Moldova	Automation and Informatics; Robotics and Mechatronics	Bachelor's Degree
Free International University of Moldova	Diplomacy, Security, Business and Communication	Master's Degree
Moldova State University	programs under expansion/implementation for the 2025–2026 academic year	Bachelor's Degree
"Ion Creangă" State Pedagogical University	programs under expansion/implementation for the 2025–2026 academic year	Bachelor's Degree

Source: compiled by the author based on data from the official websites of these universities

Important observations:

- ASEM has the most extensive dual education offer among the universities in the Republic of Moldova, including programs in economics and information technology.
- UTM was the first university to officially implement dual engineering programs at the bachelor's degree level.
- ULIM implements the dual education model at the master's degree level through the program "Diplomacy, Security, Business and Communication".
- For Moldova State University (MSU) and "Ion Creangă" State Pedagogical University (UPSC), the Ministry of Education and Research announced the expansion of the dual education model starting with the 2025–2026 academic year; however, the exact specialties have not yet been officially published.

The expansion of dual higher education also requires the consolidation of the legislative and institutional framework necessary for the efficient functioning of this educational model. An important step in this direction was the approval by the Government of the Republic of Moldova of Government Decision No. 660 of September 25, 2024, through which the "Regulation on the organization and implementation of dual education within bachelor's degree studies (Cycle I)" was adopted. The Regulation establishes the normative framework for organizing dual university studies, the mechanisms of cooperation between higher education institutions and economic agents, the rights and obligations of the parties involved, as well as the modalities for conducting practical activities within partner companies.

The document regulates the development of distinct curricula for the dual education format, the distribution of theoretical and practical training periods, the assessment of competencies acquired by students, and the direct involvement of employers in the educational process. Another important element provided by the Regulation is the possibility of adapting study programs to the real needs of the labor market and to the specific requirements of partner companies.

For example, the distribution of study activities within the traditional and dual education models at Academy of Economic Studies of Moldova was systematized by the author in the following table, based on the academic years 2022–2025. The comparative analysis highlights the differences between the conventional university education model, predominantly focused on theoretical instruction, and the dual education model, which integrates a significantly larger share of practical training carried out within partner companies (Guşuvati & Hăbăşescu, 2022). This comparison allows for a clearer understanding of the structural changes introduced through dual higher education and emphasizes its orientation toward the development of professional competencies and labor market integration.

Table 3. Comparative Analysis of the Distribution of Study Time in the Traditional and Dual Education Models within ASEM

Indicator	Traditional ASEM Model	Dual ASEM Model
Total study hours	5400 hours	5400 hours
Number of credits	180 ECTS	180 ECTS
Share of theoretical training	90%	60%
Share of practical training	10%	40%
Weeks dedicated to theoretical studies	97 weeks	flexible university–company distribution
Learning process	76 weeks	carried out both at the university and within the company
Knowledge assessment	21 weeks	academic and practical assessment
Practical training weeks	11 weeks	practice continuously integrated throughout the studies
Internship practice	4 weeks	carried out within the partner company
Bachelor's practice	7 weeks	integrated into continuous practical activity
Place of practical training	mainly at the end of studies	throughout the entire study period
Employer involvement	Limited	direct and continuous
Student status	Student	student and active participant within the company
Remuneration for practical activity	generally absent	students receive financial remuneration

Source: developed based on the data presented in Guşuvati, A., & Hăbăşescu, M. (2022). Dual education – A premise for increasing the competitiveness of future economists. <https://doi.org/10.53486/icspm2022.14>

Based on the data presented in the table, the author considers that the traditional model of organizing university studies within Academy of Economic Studies of Moldova is predominantly focused on theoretical training, allocating a relatively limited amount of time to practical activities. In contrast, the dual education model proposes a more balanced distribution of study time by increasing the share of practical training carried out within partner companies. This approach contributes to the development of professional competencies, the strengthening of practical experience, and the facilitation of students' integration into the labor market. At the same time, the direct involvement of employers in the educational process allows academic training to be adapted to the real requirements of the business environment and increases the competitiveness of future graduates.

In parallel, the recent amendments to the Education Code and the approval of complementary regulations by the Ministry of Education and Research have provided universities with the opportunity to develop flexible and interdisciplinary dual programs elaborated in cooperation with the business environment. Under these conditions, dual education is beginning to be perceived not only as an educational alternative, but also as a strategic instrument for human capital development and for increasing the competitiveness of the national economy.

The author aims to highlight an important aspect regarding the implementation process of dual higher education in the Republic of Moldova. Beginning with the 2025–2026 academic year, the Ministry of Education and Research introduced changes related to the distribution of study time and to the starting point of direct collaboration between students and partner companies. According to the new provisions, the practical activities specific to dual education will begin only from the third semester of studies.

The author considers that this decision may reduce the efficiency of students' integration into the dual education system and may create conditions that encourage the abandonment of this form of study. During the first academic year, students do not benefit from direct interaction with the professional environment and economic partners, which may decrease their initial motivation and interest in the dual program. In the absence of early practical involvement, there is a risk that some students may choose the traditional form of education or completely withdraw from the dual program.

Practical experience demonstrates that some students identify other employment opportunities during this period, often considered more attractive from a financial perspective, even if they are not directly related to their field of professional training. Furthermore, postponing the beginning of practical activities may lead to a decline in enthusiasm and in the sense of belonging to the partner company, elements that are essential for the success of the dual education model.

Another possible consequence is the reduction of students' responsibility and involvement in the educational process during the first semesters of study. Without direct exposure to the professional environment and without understanding the practical applicability of the subjects studied, students may develop a less responsible attitude toward academic tasks. This may later be reflected in their professional activity within partner companies through difficulties in adapting to organizational discipline, respecting deadlines, and carrying out assigned responsibilities.

In addition, delaying the start of dual practical training may negatively affect the gradual development of professional competencies and the establishment of a trust-based relationship between students and employers. Partner companies are interested not only in developing technical skills, but also in progressively integrating students into the organizational culture and internal processes of the company. Under these circumstances, reducing the effective period of collaboration between students and companies may limit the efficiency of professional training and the employer's ability to evaluate and prepare future specialists over the long term.

The involvement of students in practical activities from the first semesters of study could contribute to strengthening the connection between academic training and professional experience, increasing employability, and developing more effective cooperation between universities and the business environment. At the same time, early practical integration may support the continuity of students' participation in dual programs and reduce the risk of abandoning this form of education.

"Based on shared interests and accountability in the process of developing human capital, the dual education model encourages the establishment of a long-lasting collaboration between the corporate environment and the educational system. Dual education enhances graduates' competitiveness, helps them integrate into the workforce, and supports to the development of professional abilities by fusing theoretical instruction with real-world experience gained in businesses. Employers' direct involvement in the educational process also helps to close the gap between academic training and the demands of the business world by allowing study programs to be tailored to the actual needs of the economy." (Guşuvati & Hăbăşescu, 2022).

The implementation of dual higher education in the Republic of Moldova can be considered a strategic educational reform aimed at creating a more flexible, competitive, and labor market-oriented university system, closely aligned with the real needs of the national economy. Although the system is still in a stage of consolidation and expansion, the preliminary results and the interest demonstrated by both universities and economic agents confirm the significant potential of this professional training model. In the long term, the expansion of partnerships between universities and companies may

contribute to increasing economic competitiveness, developing qualified human capital, and reducing the migration of young labor force from the Republic of Moldova.

In the long term, the sustainability and efficiency of dual higher education will depend on the continuous consolidation of the legislative framework, the diversification of dual study fields, and the maintenance of an active dialogue between universities, public authorities, and the business environment. Under these conditions, the dual education model has the potential to become one of the main pillars of the modernization of the higher education system and of the sustainable economic development of the Republic of Moldova.

Conclusions

According to the author, the research results confirm that the implementation of dual higher education in the Republic of Moldova represents an important stage in the modernization of the national higher education system and in strengthening the relationship between universities and the labor market. The analysis of the institutional, legislative, and practical framework demonstrates that the dual education model contributes to the development of professional competencies, facilitates graduates' integration into employment, and supports the creation of sustainable partnerships between higher education institutions and the business sector.

The author highlights the novelty of extending the dual education model from vocational technical education to higher education institutions beginning with the 2022–2023 academic year through the implementation of pilot programs within the Academy of Economic Studies of Moldova, the Technical University of Moldova, and the Free International University of Moldova. According to the author, the obtained results indicate increasing interest from employers in participating directly in the educational process and confirm the capacity of the dual system to adapt academic training to the real needs of the economy.

At the same time, the comparative analysis between the traditional and dual education models within ASEM demonstrates that increasing the share of practical training and the direct involvement of partner companies contribute to improving students' employability and professional competitiveness. An original aspect emphasized in the research concerns the critical analysis of the recent changes introduced regarding the postponement of practical dual activities until the third semester of studies. The author believes that this decision may reduce students' motivation and continuity within dual programs and may limit the efficiency of professional integration.

The research also reveals several limitations of the current stage of implementation, including the limited number of universities involved, the reduced diversity of dual study programs, and the still developing legislative and institutional framework. According to the author, another limitation derives from the relatively recent implementation period of dual higher education, which does not yet allow for a comprehensive long-term evaluation of graduates' professional performance and career development.

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ANALYSIS OF EUROPEAN MODELS FOR THE DEVELOPMENT OF COMPETITIVE CLUSTERS AND VALUE CHAINS

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Abstract. *The examination of European methods for the creation of clusters and competitive value chains is the main subject of the article, with emphasis on adapting them to suit conditions of the Republic of Moldova.. The paper presents a comparative analysis of the cluster policies of six European Union member states-Poland, Germany, France, Lithuania, Italy, and Romania-with a focus on institutional support mechanisms, financing instruments, and monitoring systems for cluster initiatives. The authors analyze the main approaches to cluster development applied in European countries and assess their impact on innovative activity, regional development, and the integration of enterprises into international production networks. The main objective of the research is to identify effective European practices that can be applied to the formation of a sustainable cluster policy in the Republic of Moldova. To achieve this objective, the study analyzed European Union strategic documents, national cluster support programs, as well as statistical and analytical materials from international organizations. The results are presented in a comparative table that reflects the maturity level of cluster policies in the countries studied. The research confirms that the effectiveness of cluster models depends directly on the level of institutional support, sustainable funding, and the integration of participants into innovation and production networks.*

Key words: *cluster development, value chains, EU cluster policy, innovation ecosystems, regional competitiveness*

JEL: O18, R11, L14, O31, F15, R58.

Introduction

Against the backdrop of deepening European integration, the digital transformation of the economy, and intensifying global competition, the study of mechanisms for forming competitive clusters and sustainable value-added chains has taken on particular importance. In recent decades, the "European Union has actively used the cluster-based approach as a tool to stimulate innovation, increase business productivity, promote regional development, and integrate small and medium-sized enterprises into international production networks" (EU4Digital, 2023). Clusters are considered not only a territorial concentration of interconnected companies and institutions, but also a modern form of cooperation that ensures a synergistic effect between the business community, the scientific community, public authorities, and innovation infrastructure.

The relevance of this study stems from the need to enhance the competitiveness of the Moldovan economy in the context of European integration and the global transformation of markets. Of particular importance is the examination of European experience in developing clusters and value chains as an effective tool for stimulating innovation, regional development, and international cooperation. The article analyses successful models of cluster policy in European Union countries

that can be adapted to the national conditions of the Republic of Moldova. The practical significance of the research lies in the possibility of using the identified mechanisms to form a sustainable national policy in the field of clusters and to strengthen the country's innovation ecosystem. The research results can contribute to the development of effective tools to support businesses and to the integration of the Moldovan economy into European production networks.

The research problem lies in the need to identify and analyze effective European models for the development of clusters and competitive value chains, with a view to adapting them to the economic conditions in the Republic of Moldova. Particular attention is paid to institutional mechanisms for supporting clusters, financing instruments, and the integration of enterprises into international innovation and production networks aspects considered a key factor in enhancing the competitiveness of the national economy.

Modern European models of cluster development are based on the principles of innovation, digitalization, sustainable development, and cross-sectoral interaction. In European Union countries, innovative digital clusters have gained particular importance, focused on developing high-tech sectors, accelerating technology transfer, and supporting innovative ecosystems. According to studies by the EU4Digital program, effective cluster management requires sustainable partnerships, robust institutional support, efficient knowledge sharing, and the integration of participants into international value chains (EU4Digital, 2023).

European experience shows that the competitiveness of national economies is increasingly determined by the ability of businesses to integrate into global and regional value chains. In this context, the cluster-based approach becomes a tool for creating sustainable production links, boosting innovation, and expanding the export potential of regions. In EU countries, significant attention is being paid to the development of sectoral and cross-sectoral clusters in the fields of information technology, the agro-industrial complex, machine building, tourism, the creative industries, and the "green" economy (UNDP Moldova, 2024).

Basic content

The purpose of this article is to identify and analyze best practices from five EU member states regarding the development and support of economic clusters and the development of competitive value chains, including food value chains, to inform measures applicable in the context of the Republic of Moldova. Hence, to identify and analyze best practices in support of economic cluster development, five European Union member states were selected: Poland, Germany, France, Lithuania, Italy, and Romania which provide examples of policies and instruments adapted to different levels of maturity and types of industrial ecosystems. (European Commission, 2016; European Cluster Collaboration Platform, 2022).

Poland - a model of integrated support for cluster development

Poland is „a success story in terms of developing a coherent national cluster policy, characterized by institutional maturity, diversified support instruments, and a dual approach: national and regional”. (European Commission, 2016)

Poland's cluster policy has developed progressively since the 2007-2013 period, being strengthened in the 2014-2020 period through the explicit inclusion of clusters in *the Operational Program for Smart Growth (POIR)* and in other national and regional programs. (European Cluster Collaboration Platform, 2022).

A central element of the Polish strategy is *the National Key Clusters (KKK)*-clusters officially recognized for their strategic, innovative, and internationalization potential. They benefit from priority access to funding and support programs and actively contribute to the digital and green transformation of the economy. (European Commission, 2020)

Responsible institutions:

- *Ministry of Economic Development, Labor, and Technology* - policy development and coordination;

- *Polish Agency for Enterprise Development (PARP)* - evaluation and implementation of support measures;
- *Regional authorities* - implementation of smart specialization (S3) strategies at the local level (e.g., the Mazowsze region).

Objectives of the national cluster policy:

- increasing the competitiveness of SMEs through network cooperation;
- supporting internationalization and access to foreign markets;
- developing research, innovation, and technology transfer capabilities;
- promoting collaboration between the business and academic communities;
- strengthening regional innovation ecosystems. (European Commission, 2021a; European Commission, 2021b).

Support measures and instruments:

- funding for support services (marketing, trade fair participation, international branding);
- support for cluster coordinators (salaries, training, ICT, infrastructure);
- grants for SMEs that are members of **clusters** (innovation, internationalization, digitalization);
- creation of regional meta-clusters and promotion of cross-border collaboration.
- periodic evaluations and clear performance criteria for access to funds:
 1. *Economic representativeness of the cluster:*
 - Minimum number of members (usually ≥ 30 entities).
 - At least 50% SMEs.
 - Operating in a strategic sector of the economy.
 2. *Professional governance and management:*
 - Presence of a coordinator with managerial experience.
 - Multi-year strategic plan.
 - Functional decision-making mechanisms and member involvement.
 3. *Demonstrable activity in innovation and R&D:*
 - Joint research and innovation projects over the past 3 years.
 - Active partnerships with research institutions or universities.
 - Participation in funded projects (e.g., Horizon, Interreg, POIR).
 4. *Internationalization:*
 - Participation in international trade fairs, exhibitions, and networks (e.g., ECCP).
 - Cross-border collaborations or joint EU projects.
 - Concrete plan for expansion into foreign markets.
 5. *Economic impact and development potential:*
 - Increase in members' aggregate turnover.
 - Job creation.
 - Investments attracted to the region.
 6. *Organizational sustainability:*
 - Diversified funding sources (not just public funds).
 - Financial contributions from members to the cluster's budget.
 - Stable administrative structures.

The cumulative budget for cluster-dedicated programs exceeded €33 million during the 2014-2020 period, with co-financing from national and European funds (Horizon 2020, Interreg, Digital Poland, Smart Growth, etc.). (European Cluster Collaboration Platform, 2022)

Germany-a model of excellence and federal coordination in cluster development

Germany, in authors' opinion has one of the most well-established cluster support policies in the European Union, characterized by coherence, continuity, and an integrated approach at the federal and regional levels (INNO Germany AG, 2010). Cluster policy is implemented both by the federal

government, through the relevant ministries, and by the 16 states, each with its own initiatives tailored to regional specifics. (European Commission, 2016a)

Institutional and Strategic Framework

The main institutions involved in defining and implementing cluster policies are:

- *Federal Ministry for Economic Affairs and Energy (BMWi);*
- *The Federal Ministry of Education and Research (BMBF);*
- *Regional authorities (e.g., the Bavarian Ministry of Economic Affairs).*

At the national level, there are a number of **complementary programs**:

1. "go-cluster" (2012-present): a program for the professionalization and certification of high-performing clusters, managed by VDI/VDE Innovation + Technik GmbH.
2. "Zukunftscluster - Clusters of the Future" (2019-present): a strategic program aimed at strengthening emerging clusters around cutting-edge research topics and technology transfer.
3. "Clusters - Networks - International" (2014-present): supports transnational cooperation and integration into international innovation networks.
4. Cluster Bavaria Initiative (2006-present): a regional example that has achieved a high degree of maturity and replicability.

Objectives of the clustering policy

- Promoting excellence and the professionalization of cluster governance structures;
- Supporting research, development, and innovation (R&D&I) projects;
- Supporting digitalization, internationalization, and cross-sectoral cooperation;
- Integrating clusters into global value chains and innovation ecosystems;
- Ensuring an active network of clusters with regional and national impact.

Support Measures and Instruments

German policies offer a wide range of financial and technical instruments, including:

- Direct funding for R&D&I projects, internationalization initiatives, and support services;
- Grants for management infrastructure and cluster coordinators' staff;
- Certification schemes (e.g., ESCA Gold Label);
- Support for skills development, management training, and strategic partnerships;
- Promotion of clusters in international networks (through ECCP, Interreg, Horizon, etc.).

Allocated budgets and financial impact

Germany is investing significantly in cluster development:

- The "Zukunftscluster-Initiative" has a total budget of up to €450 million, allocated for applied research and industry-science collaborations.
- "Clusters - Networks - International" has a budget of €80 million for internationalization and transnational collaboration.
- "Cluster Initiative Bavaria" received €16 million in funding for the period 2020-2023.
- "go-cluster" has an annual budget of approximately €1.21 million and provides valuable non-financial support through platforms, networks, and technical assistance.

Assessment and Maturity

German cluster policies are characterized by:

- continuity (programs active from the 1990s to the present);
- periodic evaluations (e.g., the 2016 "go-cluster" evaluation, "Cluster Initiative Bavaria" in 2008, 2010, 2014, 2018);
- alignment with EU priorities: green transition, digitalization, territorial cohesion;
- high maturity, with Germany achieving the maximum score in all four dimensions of the cluster policy maturity indicator: existence, consistency, evaluation, and instruments. (European Cluster Collaboration Platform, 2022).

France - Institutional Model for Supporting Competitiveness through "Pôles de compétitivité"

France, in authors' opinion is one of the earliest and most established European models in terms of national policies dedicated to cluster development, with over two decades of institutional experience. (European Commission, 2016a). French public policy in this area is based on the concept of "*Pôles de compétitivité*"-thematic cooperation clusters structured among firms, research institutes, and universities, supported financially and strategically by the French state and regional authorities.

Institutional Framework and Responsibilities

Cluster policy in France is designed and implemented by:

- The Ministry of Economy and Finance - the main actor responsible for developing, funding, and monitoring the national policy for "Pôles de compétitivité."
- Bpifrance - the French government's public investment bank, which provides co-financing for innovation and internationalization projects carried out by clusters and their members.
- ANR (Agence Nationale de la Recherche) - the national research agency that supports scientific projects within clusters through competitive funding.
- Caisse des Dépôts et Consignations - a public investment institution involved in financing infrastructure and regional development, including through support for clusters.
- France Clusters - a national organization supporting clusters, which offers training, strategic advice, support for internationalization, and forums for the exchange of best practices.

Evolution and Phases of the Policy

The "Pôles de compétitivité" policy was launched in 2004 and unfolded in four successive phases:

- Phase I (2005-2008): creation and formal recognition of clusters.
- Phase II (2009-2012): thematic and territorial expansion.
- Phase III (2013-2018): focus on innovation and economic results.
- Phase IV (2019-2022): consolidation of excellence, rigorous evaluation, introduction of a performance labeling system.

A complementary initiative, "Grappes d'entreprises," was launched in 2009 to support microenterprises and SMEs in low-tech sectors (e.g., textiles, agri-food, shipbuilding). It remained active until 2015.

Strategic Objectives

- Fostering collaboration between the private sector, research, and academic institutions to develop innovative products and processes;
- Strengthening the ability of SMEs to compete in international markets;
- Promoting excellence in cluster management and the development of support services;
- Connecting French clusters to European and international networks;
- Supporting the ecological and digital transition through specific financing instruments.

Intervention tools

I. Financial:

- Grants for R&D projects and innovative partnerships;
- Subsidies for cluster infrastructure (offices, equipment);
- Co-financing for hiring administrative and technical staff;
- Funding for international development, participation in trade fairs, and European labeling (e.g., ESCA labels).

II. Technical and institutional:

- Training in technology transfer, intellectual property, entrepreneurship, and management;
- Support in building partnership networks at the national and European levels;
- Assistance in developing strategic plans and accessing European funds (Horizon Europe, Interreg).

Budget and Impact

- Between 2004 and 2020, €2.7 billion from government and local sources was spent to support the "Pôles de compétitivité." (European Cluster Collaboration Platform, 2022).

- The "Grappes d'entreprises" program received a cumulative budget of €25.5 million between 2009 and 2015.
- In 2019, the annual state budget allocated to clusters was €68 million.
- Funding is supplemented by private and regional contributions.

Evaluation and Results

The evaluation of Phase III (2017) showed:

- A positive impact on employment and the self-financing capacity of R&D activities (a 3:1 ratio between private contributions and public funds);
- A modest economic impact on exports, turnover, and productivity-which is why a performance labeling system and competitive selection were introduced in Phase IV;
- Evaluations are conducted **ex-post** for each cycle and include qualitative and quantitative analyses of the results achieved by cluster members.

5. Lithuania - From Institutional Innovation to Smart Specialization: A Progressive Approach to Cluster Development

Lithuania - Smart Specialization - A Progressive Approach to Cluster Development

Lithuania's cluster support policy, in our consideration has evolved from a cross-cutting approach, integrated into innovation policies (2014-2020), toward a structured smart specialization strategy (2021-2027), in line with the European Union's cohesion and green transition policy priorities. Although Lithuania does not have a dedicated national policy for clusters, they are actively promoted through innovation, digitalization, and internationalization policies. (European Cluster Collaboration Platform, 2022).

Strategic Framework and Policy Governance

During the 2014-2020 period, the main instrument was *the Lithuanian Innovation Development Programme (LIDP)*-a strategic document managed by the Ministry of Economy and Innovation, which included clusters as means of support for technology transfer, network cooperation, and entrepreneurial development.

Starting in 2022, Lithuania adopted a *new Smart Specialization Strategy for 2021-2027*, focused on increasing added value, integration into global value chains, and the creation of sustainable innovation ecosystems.

This transition reflects institutional maturation, in which clusters are considered key components in strengthening the country's RDI (research-development-innovation) capabilities.

Institutional Framework and Responsibilities

1. *Ministry of Economy and Innovation* - formulation and coordination of public policies
2. *Agency for Science, Innovation, and Technology (MITA - Mokslo, Inovacijų ir Technologijų Agentūra)* - executive and technical role: manages innovation programs, R&D vouchers, and grants for SMEs; coordinates calls for proposals and evaluations for network cooperation projects; provides operational support to clusters through consulting and networking services.
3. *KlasterLT - Lithuanian National Cluster Association* - a network-type organization composed of cluster representatives:
4. *The National Innovation Council and the Smart Specialization Committee*-strategic governance bodies involved in: interministerial coordination of innovation policy; evaluating S3 progress and the implementation of thematic priorities; and proposing integrated policies, including those to support clusters.
5. *Regional Development Agencies and municipal administrations*-support clustering initiatives at the local level.

Strategic objectives relevant to clusters. Under the LIDP (2014-2020):

- Promoting cooperation between SMEs and research institutions;
- Supporting innovative start-ups and spin-offs;
- Internationalizing clusters and integrating them into global networks;

- Strengthening professional skills in knowledge-intensive sectors;
- Applied technology transfer and support for innovation at the regional level.

Under the S3 Strategy (2021-2027):

- *Prioritizing investments in 3 areas of specialization:*
- Health technologies, biotechnology, and food security;
- Advanced materials, energy efficiency, and smart manufacturing;
- Digital technologies, AI, cybersecurity, and creative media;
- *Developing clusters as drivers of excellence and internationalization in these sectors;*
- *Stimulating transnational collaboration and participation in Horizon Europe projects.*

Instruments and measures applicable to clusters

Lithuania has used a mixed range of instruments in both programming cycles:

1. Financial instruments:

- Grants for collaborative R&D and applied innovation projects;
- Innovation vouchers, subsidies for technology and equipment procurement;
- Co-financing for participation in trade fairs, economic missions, and international networks;
- Support for training and salaries of highly qualified personnel (e.g., PhDs).

2. Non-financial instruments:

- Technical assistance for developing management capacities in clusters;
- Mentoring, coaching, and networking services;
- Promotional activities in universities, the media, and business communities;
- International events to promote a culture of innovation and collaboration.

Funding and budgetary sources

- 2014-2020 - No specific budget was allocated exclusively for clusters. The measures were funded from the Ministry of Economy's budget and European funds (ERDF, ESF).
- 2021-2027 - Lithuania signed a Partnership Agreement with the European Commission, allocating €1.132 billion for business competitiveness. The funds are directed toward clusters within regional and national programs coordinated by the Ministry of Economy and Innovation.

Evaluation and Performance

- The LIDP 2014-2020 did not provide for a formal system for evaluating cluster policy.
- Individual programs and instruments were evaluated on a case-by-case basis:
- *Inno-vouchers LT* (2017): had positive effects on science-industry collaboration, but limited impact on productivity and exports.
- *Valley Programme* (evaluated by the OECD): revealed a structure overly focused on the academic sector, with low industry participation. (European Cluster Collaboration Platform, 2022).

Italy: A Structural Transformation in Cluster Policy

Italy has shifted from the traditional model of "industrial districts" to an approach based on *national technology clusters*, launched starting in 2012. (European Commission, 2016). Cluster policy is integrated into the National Smart Specialization Strategy (SNSI) and is aligned with regional strategies (RIS3), with no national program dedicated exclusively to clusters.

Institutional Framework

- Ministry of Education, Universities, and Research (MIUR) - initiator of the technology clusters.
- Ministry of Economic Development - coordinator of the SNSI.
- The regions - implementers of the S3 regional strategies, each of which has developed its own Regional Smart Specialization Strategy.

Programs and instruments

- 2012 - launch of 8 national clusters through a public call (e.g., aerospace, agri-food, green chemistry, health).
- Budget: 368 million EUR (328 million national + 40 million EU).
- 2016 - expansion with 4 additional clusters (e.g., cultural heritage, design, energy).

- Budget: 3 million EUR (national budget).
- The clusters operate as *consortia* composed of SMEs, universities, research centers, and public administrations.

Strategic objectives relevant to clusters

National policy and RIS3 regional strategies aim to:

- Creating innovative value chains between industry, research, and government;
- Promoting cross-sectoral and cross-regional cooperation;
- Developing high-value-added products and processes;
- Internationalization and integration into EU networks;
- Strengthening the administrative capacities of cluster coordinators;
- Professionalizing human resources in high-tech fields.

Types of support

- Competitive funding through calls for RDI projects.
- Co-financing for cluster management and support infrastructure.
- Eligible activities: Collaborative R&D, internationalization, technological development, branding, professional training.

Results and evaluation

- A 2.7% increase in the number of companies involved in the thematic areas of the SNSI between 2015 and 2017.
- 51% introduced new technologies; 43% introduced new products; 36% introduced new organizational methods.
- Geographic concentration: the Northwest and Northeast of the country (over 50% of active companies).
- The assessment is partial, conducted on an ad hoc basis, without a formal national monitoring system. (European Cluster Collaboration Platform, 2022).

Romania - Cluster Policy: Between Strategic Initiatives and Operational Fragmentation

Romania began developing economic clusters in the 2000s, in the context of European policies on regional competitiveness and innovation. (Coșniță et al., 2024). Although clusters are included in relevant national strategies, the lack of a dedicated and coherent public policy has led to uneven development, intermittent support, and limited institutional capacity for implementation and evaluation.

Institutional Framework and Responsibilities

- Ministry of Economy, Entrepreneurship, and Tourism - responsible for formulating industrial and competitiveness policy, including measures related to clusters.
- Ministry of Research, Innovation, and Digitalization - coordinates the National Smart Specialization Strategy (SNSI).
- Regional Development Agencies (RDAs) - administer Regional Operational Programs, which include calls for clusters.
- ClusteRo - a national cluster organization involved in representation, training, and the dissemination of best practices.
- Fragmented coordination - there is no national structure dedicated exclusively to coordinating cluster policy.

Existing policy and strategic framework

- Romania does not have a national policy dedicated exclusively to clusters.
- Clusters are addressed as an integral part of national and regional strategies:
- National Competitiveness Strategy 2021-2027 (NCS)
- National Strategy for Smart Specialization 2021-2027 (SNSI)
- RIS3 regional strategies coordinated by RDAs.

Strategic objectives:

- increasing cooperation between firms and R&D&I;
- strengthening innovation ecosystems;
- support for the professionalization of cluster management;
- internationalization, entrepreneurship, and employment.

Support instruments

Financial instruments:

- Grants for RDI projects (e.g., POS CCE 1.3.3, POC, POCIDIF);
- Infrastructure subsidies (equipment, facilities);
- Innovation vouchers, subsidies for hiring doctoral students;
- Support for organizing trade fairs, branding, and participation in international networks.

Non-financial instruments:

- Technical assistance for organizational development;
- Access to infrastructure (science parks, incubators);
- Professional training services, IP consulting, internationalization;
- Support provided by ClusteRo and international networks (e.g., ECCP).

Funding

- There is no single, dedicated national budget for clusters.
- Funding sources are diverse and fragmented:
 - European funds: ERDF, POC, POCIDIF, POR, POS CCE;
 - Local/regional co-financing;
 - Programs managed by RDAs;
 - The PNRR does not include a direct line for clusters, but offers indirect opportunities through RDI/digitalization components.
- Funding has been available only in isolated years (2012, 2013, 2015, 2018, 2020, 2021).

Evaluation and Results

- *There is no national system for ex-ante/ex-post evaluation* of cluster policy.
- Evaluations are conducted on an ad hoc basis, primarily by ClusteRo (e.g., 2020 report). (Coșniță et al., 2024).
- Findings:
 - Lack of coherent and predictable support;
 - Calls for proposals dedicated to clusters did not reflect actual needs;
 - Despite these limitations, many clusters achieved significant results (e.g., 5 ESCA Gold Labels).

Table 1.1. Evaluation of cluster policies in 6 EU countries and the Republic of Moldova

Criterion	Poland	Germany	France	Lithuania	Italy	Romania	Moldova
Dedicated policy	Yes - An active, evaluated national policy with its own instruments (KKK)	Yes - National and regional policy, strong federal coordination	Yes - Coherent policy (Competitiveness Clusters + associated structures)	No - Clusters included only in LIDP and S3, without their own program	No - Clusters launched through calls for proposals, but without their own strategic framework	No - Clusters are addressed in the SNC and SNSI, but without a dedicated policy	No - No specific legal framework or national program
Funding	~€33 million (2014-2020), direct grants through KKK	~€450 million through Zukunftscluster + federal initiative grants	EUR 2.7 billion 2004-2020 (pôles) + complementary regional grants	Unspecified budget, multiple sources: national, municipal, and EU	€368 million (2012), €3 million (2016), MIUR calls	Fragmented: POSCCE, POCIDIF, POR (without dedicated budget)	Occasional: ODA, pilot projects, UNDP grants

Criterion	Poland	Germany	France	Lithuania	Italy	Romania	Moldova
Tools used	Grants, mentoring, internationalization, standardized assessments	Direct grants, competitive evaluation, coaching, platforms	R&D co-financing, mobility, training, access to foreign markets	Innovation vouchers, subsidies, training, internationalization	RDI calls, thematic networks, limited regional support	Indirect support: branding, IP, networking, training	Indirect support UNDP grants
Evaluation and monitoring	Yes - Formal system, clear criteria, recurring audit KKK)	Yes - Continuous federal and regional evaluation (ex-post & in-process)	Yes - Multi-level evaluation, linked to funding	Partial - Limited evaluations, no formal national framework	Partial - Occasional evaluation, without impact indicators	No - Ad hoc assessments by NGOs (e.g., ClusteRo)	No - Complete lack of a formalized system, no public data
Policy maturity (ECCP)	6.5 / 8	8 / 8	8 / 8	2 / 8	1 / 8	2 / 8	0.5 / 8

Source: elaborated by the authors based on an analysis of the legislation of the countries under review

In the authors opinion, and based on the results presented in the analysis above and in Table 1.1 there are significant differences in the level of development of cluster policy across European Union member states and the Republic of Moldova. The highest level of institutionalization of cluster initiatives is characteristic of Germany, France, and Poland, where cluster policy is integrated into national economic development strategies and supported by sustainable financing, coordination, and monitoring mechanisms. High cluster policy maturity indicators (6.5-8/8 according to the ECCP) confirm the effectiveness of a systemic approach in supporting innovative ecosystems and the development of competitive value chains.

Germany and France demonstrate complex cluster management models based on the interaction between the state, the business community, and scientific research institutions. Poland, in turn, successfully utilizes European funds and national support instruments for the development of regional and sectoral clusters. In these countries, the cluster approach serves as an important tool for boosting innovation, technological modernization, and the integration of enterprises into international markets. Lithuania, Italy, and Romania are characterized by a less systematic approach to cluster policy. Despite the existence of individual support programs and participation in European initiatives, these countries face limitations in terms of strategic coordination, effectiveness evaluation, and sustainable financing of clusters. This is particularly evident in Romania, where there is no clearly defined national strategy on clusters. The research demonstrated that the Republic of Moldova is in an early stage of cluster ecosystem development, first cluster appeared in 2018. We consider that the lack of a specialized state program, formalized monitoring mechanisms, and limited institutional support result in a low cluster policy maturity indicator (0.5/8 according to the ECCP). At the same time, support from international organizations and European programs creates the conditions for the further development of cluster initiatives.

Thus, the results of the comparative analysis confirm that the effectiveness of the cluster model is determined by the level of institutional support, the availability of sustainable funding, and the degree to which participants are integrated into innovation and production networks. For the Republic of Moldova, adapting European cluster development practices can become an important factor in increasing the competitiveness of the national economy and strengthening value chains.

Conclusions

The analysis confirms that the Republic of Moldova has real potential for developing clusters as a tool for economic growth, but is at an early stage, marked by regional, sectoral, and institutional imbalances. Most clusters are concentrated in the south of the country and in the agri-food sector,

reflecting the economy's traditional specialization, but also opportunities for development through exports and international branding. Tourism, manufacturing, and the renewable energy sector. Despite the support provided by international partners, Moldovan clusters face major obstacles: a lack of a culture of cooperation, legal uncertainties, labor migration, and a lack of shared infrastructure. All of this underscores the urgent need to develop a **National Program for Entrepreneurship Development** that provides for a clear legal definition, registration criteria, financing instruments, tax incentives, and well-defined institutional responsibilities.

Integrating this program into the national Growth Plan worth 1.8 billion EUR would enable an effective approach, ensuring compatibility with EU objectives regarding structural reforms, economic resilience, and European integration. Compared to European standards, Moldova is at a stage of partial alignment, and progress depends on institutionalizing clustering as a national priority. Only through a clear strategic framework and concrete support measures can clusters become drivers of The relevance of this study stems from the need to enhance the competitiveness of the Moldovan economy in the context of European integration and the global transformation of markets. Of particular importance is the examination of European experience in developing clusters and value chains as an effective tool for stimulating innovation, regional development, and international cooperation. The article analyzes successful models of cluster policy in European Union countries that can be adapted to the national conditions of the Republic of Moldova. The practical significance of the research lies in the possibility of using the identified mechanisms to form a sustainable national policy in the field of clusters and to strengthen the country's innovation ecosystem. The research results can contribute to the development of effective tools to support businesses and to the integration of the Moldovan economy into European production networks.

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Section 3: MANAGEMENT AND MARKETING (II)

INFRASTRUCTURE DETERMINANTS AND STRUCTURAL COMPONENTS OF POPULATION QUALITY-OF-LIFE RESILIENCE UNDER SUSTAINABLE DEVELOPMENT

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Abstract: *The article substantiates the theoretical and applied foundations for the formation of population quality-of-life resilience under sustainable development based on the identification of infrastructure determinants and structural components ensuring the stability of socio-economic systems. It is proved that under conditions of global instability, military threats, energy crises, digital transformation, and climate challenges, infrastructure acts not only as the material basis for the functioning of territories, but also as a key prerequisite for ensuring adaptability, security, and resilience of the population's quality of life. Modern scientific approaches to the interpretation of the concepts of "resilience", "infrastructure", and "population quality of life" are generalized. The key infrastructure determinants of population quality-of-life resilience formation are identified, among which energy, transport, logistics, digital, social, communal, environmental, and security infrastructure have a system-forming significance. It is substantiated that the development of these infrastructure systems determines the ability of territories to maintain functional stability, ensure continuity of population life support, and adapt to crisis impacts. The structural components of ensuring population quality-of-life resilience are systematized, namely: institutional, infrastructural, social, economic, security, digital, and environmental. A conceptual model of the interrelation of structural components of resilience provision is proposed, which makes it possible to comprehensively integrate institutional, infrastructural, social, economic, digital, security, and environmental elements into a unified system for ensuring territorial resilience. The relationship between infrastructure transformation and the provision of resilient sustainable development has been established. It is proved that infrastructure modernization should be based on the principles of sustainability, resilience, inclusiveness, energy efficiency, digital integration, and environmental responsibility. Particular attention is paid to the Build Back Better concept as the basis for the formation of resilient, energy-efficient, digitally integrated, and environmentally oriented infrastructure systems in the process of Ukraine's post-war recovery. The practical significance of the obtained results lies in the possibility of their use in the formation of state regional development policy, post-war recovery strategies, modernization of critical infrastructure, and the development of mechanisms for ensuring the infrastructural resilience of territories.*

Key words: *national economy, resilience, population quality of life, infrastructure determinants, infrastructure transformation, critical infrastructure, sustainable development, infrastructural resilience, socio-economic systems, post-war recovery, energy resilience, digital infrastructure, security infrastructure, Build Back Better, territorial adaptability, infrastructure development.*

JEL: H54, I31, O18

Introduction

In the current conditions of global instability, military risks, climate change, energy crises and digital transformation, the issues of ensuring the resilience of the quality of life of the population are of particular importance. One of the key determinants of the formation of such resilience is infrastructure as the basic basis for the functioning of socio-economic systems, ensuring the vital activity of the population, the availability of public services and maintaining the continuity of economic processes. In the international scientific discourse, infrastructure is increasingly viewed not only as a set of material and technical objects, but as a complex system of interconnected elements that ensure the resilience of territories to external and internal challenges. In this context, the issues of developing energy, transport, logistics, digital, social and communal infrastructure are of particular importance, which directly affect the level of security, availability of services, social well-being and quality of life of the population.

For Ukraine, the issue of infrastructure resilience has become particularly relevant in the context of a full-scale war, accompanied by large-scale destruction of critical facilities, disruption of logistical connections, energy instability, deterioration of the population's access to basic services, and significant socio-economic losses. According to international organizations, a significant part of the damage falls on energy, transport, housing and communal services, and social infrastructure facilities, the restoration of which is a necessary prerequisite for ensuring sustainable development and improving the quality of life of the population.

At the same time, modern approaches to building resilience in the quality of life of the population require a transition from a fragmented consideration of individual infrastructure elements to a systematic analysis of infrastructure determinants and structural components that determine the ability of territories, communities, and socio-economic systems to adapt to crisis impacts, maintain functional stability, and ensure an adequate level of life for the population.

In foreign studies, issues of infrastructure resilience are mostly analyzed through the prism of the concepts of sustainable development, climate resilience, urban resilience, smart infrastructure, critical infrastructure protection and risk-oriented management. However, the issues of comprehensive determination of infrastructure determinants and structural components of the formation of resilience of the quality of life of the population in the conditions of modern transformation processes, digitalization of the economy and post-war reconstruction of territories remain insufficiently studied. In this regard, the purpose of the article is to substantiate the infrastructure determinants and structural components of the formation of resilience of the quality of life of the population in the conditions of sustainable development. To achieve the set goal, it is planned to: (1) summarize modern scientific approaches to the interpretation of the concepts of "resilience", "infrastructure" and "quality of life of the population"; (2) identify key infrastructure determinants of the formation of resilience; (3) systematize the structural components of ensuring resilience of the quality of life of the population; (4) substantiate the relationship between infrastructure transformation and the achievement of sustainable development goals.

Thus, the study of infrastructure determinants and structural components of the formation of resilience of the quality of life of the population has important theoretical and applied significance for ensuring sustainable development of territories, increasing the adaptability of socio-economic systems and forming effective mechanisms for the post-war recovery of Ukraine.

Basic content

In the current conditions of global instability, increased military, energy, climate and socio-economic risks, the concept of resilience has acquired special importance in the research of sustainable development, territorial security and ensuring the quality of life of the population. Transformational processes taking place in the world economy, the digitalization of society, the growth of the

interdependence of critical infrastructure and the aggravation of crisis phenomena necessitate the formation of new approaches to ensuring the stability of socio-economic systems (Holling, 1973; Walker et al., 2004; Folke, 2006). The concept of "resilience" was originally formed in ecological theory and was interpreted as the ability of a system to maintain equilibrium and restore functioning after the impact of external disturbances (Holling, 1973). Later, the concept of resilience acquired an interdisciplinary character and was extended to social, economic, managerial, urban and infrastructure systems (Walker et al., 2004; Meerow et al., 2016). In modern research, resilience is mainly considered the ability of a system to adapt to crisis impacts, maintain functional stability, minimize the negative consequences of threats and ensure recovery and further development (Folke et al., 2010).

The modern evolution of scientific approaches to the interpretation of resilience indicates a gradual transition from a narrow understanding of resilience as the ability of a system to return to its previous state to a comprehensive vision of resilience as an integrated characteristic of adaptability, flexibility, transformative ability and continuity of functioning of socio-economic systems (*Table 1*).

Table 1. Evolution of Scientific Approaches to the Interpretation of Resilience

Scientific approach	Characteristics of the approach
Ecological	Resilience is interpreted as the ability of a system to maintain equilibrium and recover after external impacts
Social	Primary attention is focused on societal adaptability, social cohesion, and the ability of the population to respond to crisis phenomena
Economic	Resilience is considered as the stability of economic systems to risks, crises, and external shocks
Urban	Emphasis is placed on the resilience of cities, territories, and population life-support systems
Infrastructural	Defined by the ability of critical infrastructure to ensure continuity of functioning and rapid recovery
Integrated	Provides for the integration of social, economic, environmental, institutional, and infrastructural components of resilience

Source: compiled by the authors based on the generalization of studies (Holling, 1973; Walker et al., 2004; Folke, 2006; Folke et al., 2010; Meerow et al., 2016; OECD, 2023).

In scientific discourse, the concept of infrastructure resilience is of particular importance, according to which infrastructure is considered a system-forming basis for ensuring the stability of territories, the security of the population and the continuity of the functioning of socio-economic systems (UNDRR, 2022). In this context, infrastructure resilience encompasses the ability of energy, transport, logistics, digital, municipal and social systems to adapt to crisis impacts, maintain functionality in emergency conditions and ensure rapid recovery from threats (Directive (EU) 2022/2557).

For Ukraine, the issue of infrastructure resilience is particularly relevant in the context of a full-scale war, accompanied by large-scale destruction of critical facilities, energy attacks, disruption of logistical communications, digital threats, and significant socio-economic losses (Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b). Under such conditions, ensuring the resilience of infrastructure systems directly affects the level of population security, availability of basic services, social stability, and the possibilities of post-war reconstruction of territories.

At the same time, the concept of "quality of life of the population" in modern research is considered a multidimensional category that characterizes the level of social well-being, accessibility of medical, educational, housing and communal, transport and digital services, safety of residence, ecological state of the environment and living conditions of the population (Cherenko et al., 2023). In this

context, it is advisable to link the resilience of the quality of life of the population not only with the level of material security, but also with the ability of the socio-economic system to maintain proper living conditions in conditions of crisis influences.

Taking into account the generalization of modern scientific approaches, it is advisable to understand the set of interconnected infrastructure systems, the conditions of their functioning and mechanisms for ensuring stability, which determine the ability of socio-economic systems to maintain an adequate level of living conditions of the population, adapt to crisis influences and ensure sustainable development of territories.

Unlike existing approaches, the proposed interpretation allows for a comprehensive integration of infrastructural, social, economic, security, digital and environmental aspects of ensuring the resilience of the quality of life of the population, which creates the basis for the formation of a holistic approach to studying the resilience of territories in modern conditions of global challenges.

Therefore, ensuring the resilience of the quality of life of the population requires a systematic identification of key infrastructure determinants (*Table 2*), which form the adaptive potential of territories, ensure the continuity of the functioning of critically important systems and determine the sustainability of socio-economic development in the conditions of modern transformation processes.

Table 2. Infrastructure Determinants of Population Quality-of-Life Resilience Formation

Infrastructure determinant	Impact on ensuring population quality-of-life resilience
Energy infrastructure	Ensures energy security, continuity of functioning of critical systems, and stability of population life support
Transport infrastructure	Forms population mobility, territorial accessibility, and resilience of transport and logistics connections
Logistics infrastructure	Ensures uninterrupted supply of food, medicines, humanitarian resources, and essential goods
Digital infrastructure	Promotes the development of digital services, e-governance, remote forms of interaction, and information resilience
Social infrastructure	Determines the accessibility of healthcare, educational, cultural, and social services
Utility infrastructure	Ensures proper living conditions, water and heat supply, and sanitary safety
Environmental infrastructure	Forms environmental resilience of territories and adaptability to climate change
Security infrastructure	Ensures the functioning of civil protection systems, crisis response, and minimization of emergency consequences

Source: compiled by the authors based on the generalization of studies (OECD, 2023; Gopalakrishnan & Peeta, 2010; Directive (EU) 2022/2557; Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b; Padgett et al., 2012).

As evidenced by the results of research by international organizations, it is infrastructure systems that ensure the basic resilience of territories to crisis phenomena and determine the level of social adaptability of the population (OECD, 2023; Meerow et al., 2016). At the same time, the insufficient level of infrastructure development leads to increased social vulnerability, worsening of the population's access to basic services, increasing territorial disparities and reducing the level of security of life (Lamond et al., 2015).

Energy infrastructure is of particular importance in modern conditions as a key determinant of ensuring the functional stability of socio-economic systems. Energy security directly affects the stability of medical institutions, water supply systems, transport, communications, digital services and other critically important areas of life of the population. In the context of the post-war reconstruction of Ukraine, the issues of developing distributed energy systems, smart grid

technologies, energy efficiency and decentralization of energy infrastructure are of priority importance (OECD, 2024).

At the same time, the role of digital infrastructure, which ensures the functioning of e-government, distance education, telemedicine, digital financial services and crisis information systems for the population, is growing significantly. In modern conditions, digital resilience is becoming an important component of the overall resilience of territories and socio-economic systems (World Bank, 2023).

It should be noted that infrastructure determinants are interdependent. Disruption of the functioning of one infrastructure system can cause cascading effects, i.e., cascading negative consequences for other sectors of the economy and areas of public life (European Commission, 2023). For example, damage to energy infrastructure can lead to disruptions in the operation of transport systems, water supply systems, communications, medical institutions and digital services.

In modern conditions, security infrastructure, which covers civil protection systems, crisis response, risk management and ensuring the continuity of the functioning of critical facilities (Directive (EU) 2022/2557), is also of particular importance. The growth of military, terrorist, cyber and technogenic threats necessitates the formation of a comprehensive approach to ensuring the infrastructural security of territories.

In addition, an important direction for the formation of resilience of the quality of life of the population is the development of ecological infrastructure, which ensures the adaptation of territories to climate change, the minimization of environmental risks and the creation of a safe environment for the population's life (UNEP, 2023). In this context, ecological sustainability is increasingly integrated into modern approaches to infrastructure development and territorial management.

Thus, infrastructure determinants form the system-forming basis for ensuring the resilience of the quality of life of the population and determine the ability of socio-economic systems to maintain functional stability, adaptability and security in the face of modern global challenges. At the same time, ensuring effective interaction between infrastructure, institutional, social and security elements requires the formation of a comprehensive structural model of resilience, which necessitates the identification of its key structural components.

Taking into account the generalization of modern theoretical approaches, the author's approach to structuring the components of ensuring the resilience of the population's quality of life is proposed, which involves the integration of institutional, infrastructural, social, economic, security, digital and environmental components into a single system for ensuring the stability of territories. Unlike existing approaches, the proposed structuring allows for a comprehensive combination of infrastructural, managerial, social, security and environmental aspects of resilience formation in the context of modern global challenges, which creates the basis for the formation of a holistic mechanism for ensuring the sustainable development of territories. The main structural components of ensuring the resilience of the population's quality of life are given in *Table 3*.

Table 3. Structural Components of Ensuring Population Quality-of-Life Resilience

Structural component	Functional role in ensuring resilience
Institutional	Forms the system of public administration, legal regulation, strategic planning, and interagency coordination
Infrastructural	Ensures the functioning of critical, transport, energy, digital, social, and utility infrastructure
Social	Determines the level of social cohesion, human capital development, accessibility of social services, and population adaptability
Economic	Forms financial stability, investment potential, economic security, and resource support for development
Security	Ensures civil protection, crisis response, risk management, and minimization of threat consequences

Digital	Promotes the development of digital infrastructure, cybersecurity, digital services, and data management systems
Environmental	Ensures environmental security, adaptation to climate change, and environmental resilience of territories

Source: compiled by the authors based on the generalization of studies (Meerow et al., 2016; OECD, 2023; Gopalakrishnan & Peeta, 2010; Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b).

The key role in ensuring the resilience of the quality of life of the population is played by the institutional component, which forms the regulatory, legal and organizational and managerial basis for the functioning of the system. It is the effectiveness of public administration, intersectoral coordination, strategic planning and institutional interaction that determines the ability of territories to adapt to crisis impacts and ensure the stability of socio-economic processes (OECD, 2023). In modern conditions, the development of adaptive governance, which involves the flexibility of management decisions, a risk-oriented approach and the integration of crisis response mechanisms, is of particular importance. At the same time, the infrastructure component forms the material and technical basis for ensuring the vital activity of the population and the continuity of the functioning of critical systems. The development of resilient infrastructure involves ensuring adaptability, reliability, energy efficiency, digital integration and the ability to quickly recover from crisis impacts (UNDRR, 2022; Directive (EU) 2022/2557). It is the infrastructural sustainability that determines the capabilities of the energy supply, transport, communications, healthcare, education and housing and communal services systems.

The social component ensures the adaptability of the population to crisis situations and is directly related to the level of social cohesion, trust in society, human capital development and accessibility of basic services. Studies by international organizations show that it is the social sustainability of the population that largely determines the ability of territories to effectively respond to emergencies and maintain stable development (United Nations, 2015). In this context, the issues of developing education, healthcare, social protection and supporting vulnerable groups of the population become important.

The economic component ensures the financial sustainability of territories, investment capacity and resource provision for development. In the context of modern crises, economic sustainability determines the capabilities of maintaining the functioning of infrastructure systems, implementing programs for the restoration and modernization of territories. Diversification of funding sources, the development of public-private partnerships and the attraction of international financial support are of particular importance.

The security component covers civil protection, crisis response, risk management and mitigation of the consequences of emergencies. Military actions, energy attacks, terrorist threats and cyber risks significantly increase the importance of the security component in shaping the resilience of territories (European Commission, 2023). In this context, ensuring the security of critical infrastructure, developing early response systems and forming mechanisms for interdepartmental coordination are of priority importance.

The digital component ensures the information stability of socio-economic systems, the continuity of digital services and the adaptability of management processes in the face of crisis impacts. The development of digital platforms, e-governance, information and communication technologies and cybersecurity systems contributes to increasing the efficiency of territorial management and expanding the population's access to services (World Bank, 2023). In modern conditions, digital stability is increasingly seen as one of the key prerequisites for ensuring the functional continuity of territories.

At the same time, the ecological component reflects the level of ecological safety, adaptation of territories to climate change and ecological sustainability of the living environment of the population.

The growth of the scale of natural disasters, climate risks and man-made threats necessitates the integration of ecological principles into the processes of infrastructure planning and territorial development. In this context, ecological sustainability is increasingly integrated into modern models of ensuring the resilience of territories. Given the interdependence of structural components of ensuring the resilience of the quality of life of the population, it is advisable to form a conceptual model that reflects the systemic nature of the interaction of institutional, infrastructural, social, economic, security, digital and environmental components (*Fig.*).

The proposed conceptual model demonstrates that the resilience of the quality of life of the population is formed as a result of the complex interaction of institutional, infrastructural, social, economic, security, digital and environmental components. At the same time, the institutional and infrastructural components create the basic conditions for the functioning of the system, the social and economic ones ensure the adaptability and sustainability of development, and the digital, environmental and security components form mechanisms for responding to modern global challenges. The combined interaction of these components ensures the formation of resilience of the quality of life of the population as the basis for sustainable development of territories.

Thus, the resilience of the quality of life of the population is formed under the influence of interconnected structural components, the effective interaction of which ensures the stability, adaptability, security and ability of socio-economic systems to recover in the conditions of modern global challenges. At the same time, the development of structural components of resilience requires the integration of the principles of infrastructure modernization, digital transformation, environmental sustainability and security management, which creates the basis for ensuring sustainable development of territories.

It should be noted that infrastructure transformation is of particular importance in the context of achieving the UN Sustainable Development Goals (SDGs), since infrastructure development directly affects economic well-being, accessibility of basic services, energy security, environmental sustainability and social inclusion (United Nations, 2024).

In this context, the following are of key importance: SDG 3 "Good health and well-being"; SDG 7 "Affordable and clean energy"; SDG 9 "Industry, innovation and infrastructure"; SDG 11 "Sustainable cities and communities"; SDG 13 "Climate change mitigation" (United Nations, 2024)

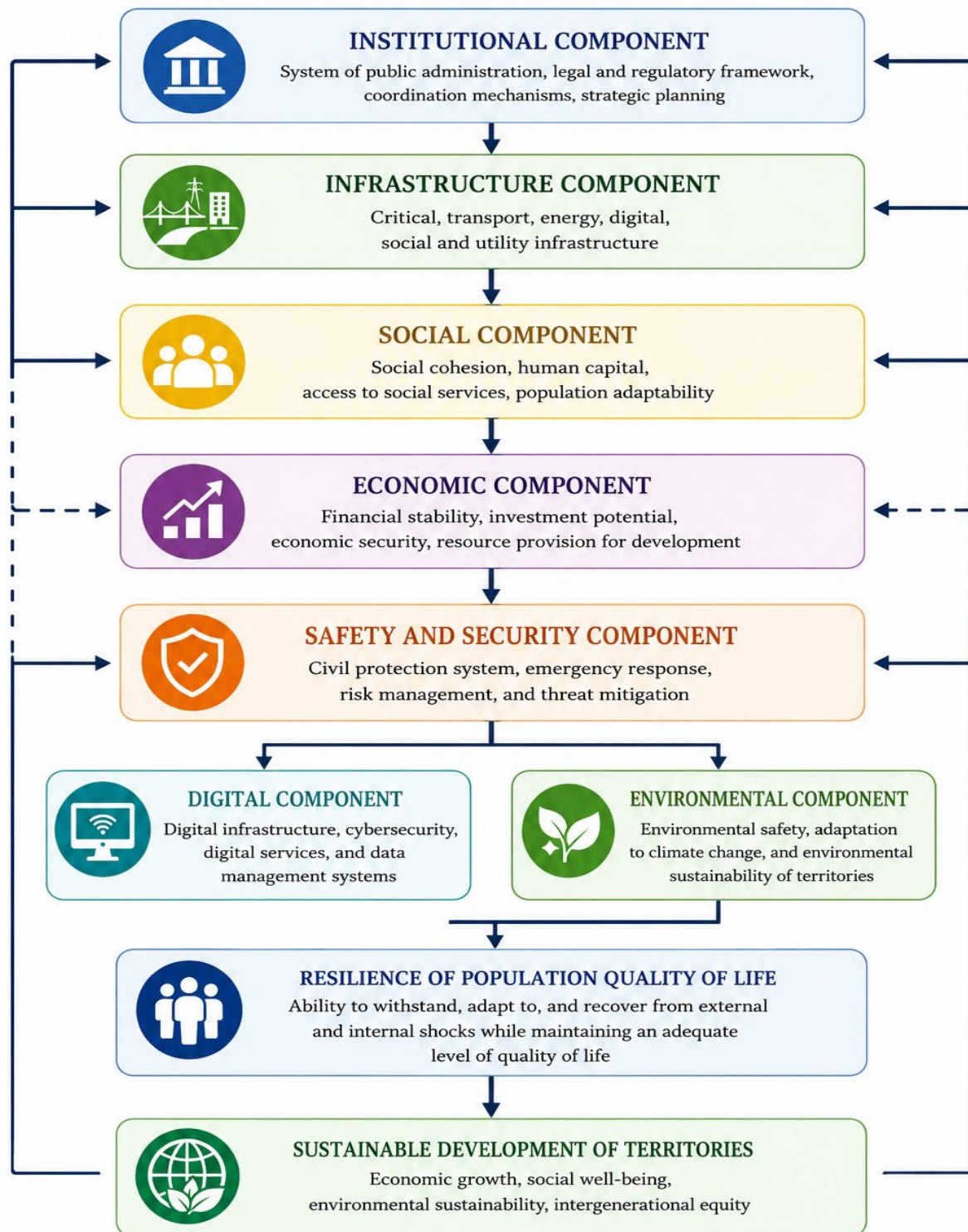


Figure. Conceptual Model of the Interrelation of Structural Components for Ensuring Population Quality-of-Life Resilience

Source: developed by the authors based on (Khaustova et al., 2025a, 2025b; Kyzym et al., 2025a, 2025b).

Taking into account modern approaches, it is advisable to determine the main directions of the impact of infrastructure transformation on ensuring resilient sustainable development of territories (Table 4).

Table 4. Impact of Infrastructure Transformation on Ensuring Resilient Sustainable Development

Direction of infrastructure transformation	Result for resilient sustainable development
Modernization of energy infrastructure	Enhancement of energy security, decarbonization of the economy, and ensuring the energy resilience of territories
Development of digital infrastructure	Ensuring digital resilience, development of e-governance, and improvement of service accessibility
Transformation of transport and logistics infrastructure	Increasing population mobility, territorial integration, and ensuring the resilience of logistics connections
Development of social infrastructure	Improving access to healthcare, educational, and social services, as well as enhancing social adaptability
Implementation of smart infrastructure	Increasing the efficiency of resource management, territorial adaptability, and responsiveness of crisis management
Development of environmental infrastructure	Reducing environmental pressure, adapting to climate change, and ensuring environmental resilience
Formation of secure infrastructure	Increasing the resilience of territories to military, technological, and crisis threats

Source: compiled by the authors based on the generalization of studies (United Nations, 2015, 2024; Directive (EU) 2022/2557; Meerow et al., 2016; Gopalakrishnan & Peeta, 2010; World Bank, 2023; European Commission, 2023).

According to the results of research by international organizations, the development of modern infrastructure is a basic condition for ensuring economic competitiveness, the investment attractiveness of territories and long-term social stability (OECD, 2023). At the same time, an insufficient level of infrastructure development leads to an increase in socio-economic disparities, territorial inequality and infrastructure vulnerability.

In the international practice of post-crisis recovery, the Build Back Better concept is of particular importance, which involves the transformation of the traditional recovery model towards the formation of resilient, energy-efficient, digitally integrated and environmentally oriented infrastructure systems (OECD, 2024). In modern conditions, this concept becomes the basis for the formation of a new model of territorial development of Ukraine, focused on the long-term sustainability of socio-economic systems.

In the context of the post-war recovery of Ukraine, the implementation of the Build Back Better concept should include:

- modernization of critical infrastructure;
- development of distributed energy systems;
- digital transformation of territories;
- greening of infrastructure solutions;
- integration of climate adaptation principles;
- formation of a safe and inclusive living environment for the population (Batty et al., 2012).

Therefore, infrastructure transformation is a strategic prerequisite for ensuring resilient sustainable development and forming a sustainable quality of life for the population. In modern conditions, infrastructure development should be based on the integration of economic, social, environmental, digital and security priorities, which will ensure increased adaptability of socio-economic systems to modern global challenges and create a basis for long-term sustainable development of territories.

Conclusions

As a result of the conducted research, the theoretical and applied principles of forming the resilience of the quality of life of the population in the conditions of sustainable development were substantiated

based on the definition of infrastructure determinants and structural components of ensuring the stability of socio-economic systems. It was proved that in modern conditions of global instability, military threats, energy crises, digital transformation and climate challenges, infrastructure acts not only as a material basis for the functioning of territories, but also as a key determinant of ensuring adaptability, security and stability of the quality of life of the population.

The conducted research allowed us to establish that the resilience of the quality of life of the population should be considered as an integral ability of the socio-economic system, infrastructure environment and institutional mechanisms to ensure the continuity of the population's vital activities, maintain the availability of basic services, adapt to crisis impacts and ensure the restoration of territories in compliance with the principles of sustainable development.

The study identified key infrastructure determinants of the resilience of the quality of life of the population, among which energy, transport, logistics, digital, social, communal, environmental and security infrastructure are of systemic importance. It is substantiated that it is the level of development of these infrastructure systems that determines the ability of territories to ensure the stability of socio-economic processes, support the functioning of critically important facilities and minimize the negative consequences of modern crisis impacts.

It was established that in the conditions of modern transformation processes, the development of distributed energy systems, the implementation of smart grid technologies, the digitalization of infrastructure systems, the modernization of transport and logistics infrastructure, the development of crisis response systems and the formation of environmentally oriented energy-efficient infrastructure are of priority importance. It is proven that the decentralization of infrastructure systems and the implementation of digital technologies contribute to increasing the adaptability of territories and reducing their vulnerability to crisis and military threats.

As a result of the study, the structural components of ensuring the resilience of the quality of life of the population were systematized, namely, institutional, infrastructural, social, economic, security, digital and environmental. It was proven that the effective interaction of these components forms a holistic system of ensuring the resilience of territories and the adaptability of socio-economic systems to modern global challenges. The proposed conceptual model of the relationship of structural components allows for the comprehensive integration of institutional, infrastructural, social, economic, security, digital and environmental components into a single system of ensuring the resilience of the quality of life of the population.

Based on the analysis, the relationship between infrastructural transformation and ensuring resilient sustainable development of territories was established. It was substantiated that infrastructure modernization should be carried out on the principles of sustainability, resilience, inclusiveness, energy efficiency, digital integration and environmental responsibility. It is proven that modern infrastructure transformation should be considered not only as a process of technical renewal of infrastructure systems, but as a comprehensive mechanism for the formation of sustainable, adaptive and safe models of territorial development.

Of particular importance in modern conditions is the implementation of the Build Back Better concept, which involves the transition from the traditional model of post-crisis recovery to the formation of resilient, energy-efficient, digitally integrated and environmentally oriented infrastructure systems. In the context of the post-war recovery of Ukraine, this creates the basis for the formation of a new model of territorial development, focused on the long-term sustainability and security of socio-economic systems.

The scientific novelty of the study lies in the substantiation of the infrastructural determinants of the formation of resilience of the quality of life of the population, the systematization of the structural components of ensuring resilience and the development of a conceptual model of the relationship between institutional, infrastructural, social, economic, digital, security and environmental components in the context of ensuring sustainable development of territories.

The practical significance of the results obtained lies in the possibility of their use:

- by state authorities – in the formation of state regional development policy, post-war recovery programs and strategies for ensuring infrastructure resilience;
- by local governments – in the development of development plans for territorial communities, modernization of critical infrastructure and implementation of crisis response mechanisms;
- by critical infrastructure entities – to improve risk management systems, ensure continuity of operation and increase the adaptability of infrastructure systems;
- in the energy sector – in the development of distributed energy systems, smart-grid solutions and energy-efficient infrastructure;
- in the process of digital transformation of territories – for the development of e-governance, digital management platforms and cybersecurity systems;
- in scientific and analytical activities – as a theoretical and methodological basis for further assessment of the level of resilience of the quality of life of the population.

Taking into account the results obtained, it is advisable to recommend:

- 1) integrate the principles of infrastructure resilience into the state policy of regional development and post-war reconstruction of Ukraine;
- 2) activate the development of distributed energy systems and local energy networks to increase the energy sustainability of territorial communities;
- 3) ensure the digitalization of infrastructure management systems and the implementation of smart infrastructure technologies;
- 4) strengthen the mechanisms of public-private partnership in the field of modernization of critical infrastructure;
- 5) develop a system for monitoring and assessing the level of infrastructure resilience of territories using integral indicators;
- 6) ensure the integration of environmental, climate and security criteria into infrastructure planning processes.

Prospects for further research are to develop a methodological approach to assessing the level of resilience of the quality of life of the population based on a system of indicators and theoretical and methodological substantiation of the integral index of infrastructure resilience of territories. Separate scientific study is required on the issues of digital resilience of communities, assessment of cascading effects and adaptation of infrastructure systems to climate and military threats.

Thus, ensuring the resilience of the quality of life of the population should be considered a strategic priority of state policy and territorial development, the implementation of which requires a comprehensive infrastructure transformation, integration of the principles of sustainable development and the formation of adaptive mechanisms for responding to modern global challenges.

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ALIGNING SMEs WITH SUSTAINABILITY PRINCIPLES

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Abstract: *Sustainability for small and medium-sized enterprises involves the balanced integration of economic, social, environmental and governance objectives into their daily activity. For SMEs, sustainable development does not only mean reducing negative environmental impact, but also using resources efficiently, strengthening responsibility toward employees and the community, respecting ethical principles and maintaining stable economic performance in the long term. The purpose of this paper is to analyze the main sustainability principles applicable to SMEs and to highlight their role in increasing competitiveness and resilience. The research methodology is based on qualitative analysis, comparative analysis and the examination of specialized literature and sustainability frameworks. The findings emphasize that the adoption of ESG principles contributes to improved operational efficiency, stronger stakeholder trust, better access to financing and long-term business stability. At the same time, SMEs face challenges related to limited financial resources, managerial expertise and access to green technologies. Therefore, sustainability should be integrated into the strategic development of SMEs and supported through institutional initiatives and simplified sustainability reporting frameworks.*

Key words: *SMEs, sustainability, ESG, circular economy, green transition, governance.*

JEL: Q56, M14, L25

Introduction

In recent years, sustainability has become an important strategic direction both internationally and nationally. It is increasingly present in economic policies, corporate development strategies and requirements related to corporate governance. The European Green Deal, ESG standards and accelerated digitalization have pushed enterprises to rethink their operating models and adopt more responsible business practices.

In the Republic of Moldova, sustainability is particularly important because SMEs represent the overwhelming majority of active enterprises and play a significant role in employment, value creation and local economic development. However, many of these enterprises face difficulties related to access to finance, green technologies, innovation, managerial expertise and specialized knowledge regarding the implementation of sustainable principles.

SMEs can make a significant contribution to the transition toward a sustainable economy due to their flexibility, adaptability and direct connection with local communities. Compared with large companies, they can sometimes implement innovative solutions more quickly, but they need a clear managerial framework adapted to their limited resources.

The research methodology is based on qualitative analysis, comparative analysis of sustainability concepts, ESG frameworks and specialized literature related to SMEs and sustainable development. The objective of the paper is to identify the main sustainability dimensions applicable to SMEs and

to highlight the opportunities and challenges associated with the implementation of ESG principles. In the context of European integration, the Republic of Moldova aims to bring its economic practices closer to European Union standards, and this process also involves preparing SMEs for sustainability and corporate responsibility requirements.

Basic Content

The adoption of ESG principles can offer companies several advantages. In addition to supporting sustainable development, these principles can improve a company's image, increase the trust of partners and consumers, and facilitate access to foreign markets. For this reason, sustainability should no longer be seen only as an obligation or trend, but as a necessary element for long-term competitiveness.

For many SMEs, the transition toward a sustainable business model may seem difficult. Enterprises may understand the need for change, but they do not always know where to begin. The lack of clear standards, limited financial resources and differences between economic sectors make the process complex. Moreover, not all sustainability aspects are equally relevant for every enterprise.

A sustainable transition requires changes throughout the entire organization. It is not only a decision made by management, but a process that requires the involvement of all people within the enterprise. Managers must establish the strategic direction, while employees must actively participate in applying concrete measures (Accountancy Europe, 2023).

The main sustainability principles for SMEs can be grouped into four categories: environmental sustainability, social sustainability, economic sustainability and governance. Environmental sustainability aims to reduce the negative effects of economic activity on nature. For SMEs, this principle can be applied through the use of cleaner technologies and production methods, reducing energy consumption, efficient waste management, responsible use of natural resources and gradually moving from a linear economy to a circular economy (Asirom, 2025).

In the linear economic model, resources are extracted, used and then discarded as waste. This system focuses on production and immediate profit, without sufficiently valuing materials left after consumption. In the long term, the linear economy leads to pollution, resource loss and increased greenhouse gas emissions (Rabadji & Borş, 2024).

By contrast, the circular economy promotes reuse, repair, recycling and the extension of product life cycles. For SMEs, this can mean lower costs, more efficient use of raw materials and the creation of products or services that are more attractive to environmentally conscious consumers (Organizația Femeilor Antreprenori, 2025).

The green transition is becoming increasingly important for SMEs in Europe and in the Republic of Moldova. Enterprises that invest in green solutions can obtain important economic advantages, such as lower operating costs, better access to finance and a stronger market image (Tambovceva & Titko, 2020).

According to the classifications, sustainable development covers several dimensions, of which the following stand out in the long term: conservation of animal and plant species, meeting the basic needs of the anthropogenic factor and promoting equity between generations by adopting development policies aimed at access to resources and fair distribution of costs and responsibilities (Popa, V., 2023).

Table 1. Proposed Values for the Main Dimensions of Sustainable Development for the 2030 Horizon

Dimension	Indicator	Threshold 2030
Protecting long-term ecological sustainability	Annual per capita ecological footprint	Max 2.3 gha per capita
Meeting basic human needs	Human Development Index	Min 0.630

Promoting equity	intergenerational	Gini coefficient	Max 40
Promoting equity	intragenerational	Renewable energy share	Min 27%

Source: elaborated by the author based on Popa, V. (2023).

Social Sustainability. Social sustainability refers to the way enterprises affect people: employees, customers, partners and the community in which they operate. For SMEs, this principle includes:

- ensuring a safe and fair working environment;
- respecting employees' rights;
- promoting equal opportunities;
- involvement in community projects;
- adopting ethical and transparent behavior;
- supporting vulnerable groups.

An enterprise does not function separately from society. It is part of a community and has a direct influence on it. Therefore, social responsibility should not be specific only to large corporations, but also to SMEs. Even if their resources are more limited, they can contribute to the common good through concrete and realistic actions.

In the Republic of Moldova, social inequalities, limited access to education and economic difficulties affect many families and young people. Some people cannot continue their studies because of material shortages, while others need support for social and professional integration. SMEs can contribute to reducing these problems through cooperation with non-governmental organizations, support for educational projects, internships, donations, scholarships or training programs.

Social responsibility also strengthens the reputation of an enterprise. A company that treats its employees fairly, respects the community and acts ethically can gain the trust of customers and partners more easily. At the same time, a healthy and fair working environment can increase employee motivation and reduce staff turnover (Kastel Group, 2023).

Social sustainability should be seen as an investment in the long-term stability of the enterprise. A company that ignores social issues may face difficulties in attracting employees, retaining customers and maintaining a positive image.

Economic Sustainability. Economic sustainability refers to an enterprise's ability to remain profitable and competitive in the long term without compromising social responsibility and environmental protection. It includes:

- prudent financial planning;
- innovation in products and services;
- adaptation to market changes;
- risk management;
- increased operational efficiency;
- strengthening business resilience.

SMEs are considered a central element of the European economy and play an important role in local development. However, they are vulnerable to sudden changes such as economic crises, pandemics, energy price increases, legislative changes or supply chain disruptions (UN Documents, 2003).

The COVID-19 pandemic showed how important adaptability is. Enterprises that had flexible business models, digital channels and stable supplier relationships were better able to cope with difficult periods. This shows that economic sustainability is not limited to profit, but also includes the ability to withstand risks (Agung, S. and Sutrisno, 2019).

One important risk for SMEs is maintaining an outdated business model. If an enterprise does not analyze its production methods, resource consumption, customer relations and environmental impact,

it may lose relevance on the market. Customers, investors and partners are increasingly attentive to the sustainable behavior of companies.

Another risk is the loss of competitive advantage. More and more companies are integrating sustainability into their strategies by developing green products, responsible services and more efficient processes. SMEs that do not adapt may be overtaken by competitors. For example, according to the Eurobarometer, in 2016 three quarters of responding SMEs had already undertaken some circular economy activities. Even among the smallest enterprises this number was 72%.

Regulations also represent an important pressure. European legislation and sustainability reporting requirements are becoming stricter. Even if many obligations apply directly to large companies, SMEs may be affected indirectly through supply chains. Large companies may require suppliers to provide information about emissions, ethics, working conditions or resource consumption (GRI, 2020).

Access to finance may also be influenced by sustainability performance. Banks and investors are paying increasing attention to ESG criteria. In the future, enterprises that cannot demonstrate responsible practices may face difficulties in obtaining loans or investments.

Therefore, economic sustainability should not be viewed as a burden, but as a condition for the survival and development of SMEs.

Governance. Governance represents the way an enterprise is managed, controlled and held accountable. In the context of sustainability, governance means integrating ESG principles into strategic decisions and daily business activity.

For SMEs, sustainable governance includes:

- transparent decision-making;
- compliance with legislation;
- anti-corruption measures;
- clear internal policies;
- reporting relevant information;
- accountability toward partners, employees and the community.

Corporate governance plays an important role in building trust. Investors, customers, authorities and business partners prefer to work with enterprises that act transparently and responsibly. The lack of clear rules can lead to legal, reputational and financial risks.

A relevant example for SMEs is the voluntary VSME standard developed by EFRAG for non-listed micro, small and medium-sized enterprises. It provides a simplified framework for sustainability reporting and helps SMEs present essential information about their activity. Important reporting aspects include the identification of the enterprise, its legal structure, field of activity, management mechanisms, ethics policies and compliance measures. These elements help SMEs organize their information better and respond to requirements from partners, financiers or authorities (Chifan, D., 2026).

Governance should not be perceived as a simple administrative formality. It is the foundation of stable and responsible development. A well-managed enterprise can make better decisions, prevent risks and build lasting relationships with stakeholders.

Conclusions

Aligning SMEs with sustainability principles is an essential condition for their long-term development. In the context of economic, social and environmental changes, small and medium-sized enterprises can no longer treat sustainability as a secondary issue. It must be integrated into the overall business strategy, internal processes and relationships with employees, customers, suppliers and the community.

Environmental sustainability helps SMEs reduce waste, use resources efficiently and become more resilient to climate change. Social sustainability strengthens the relationship between the enterprise,

employees and the community. Economic sustainability ensures stability, profitability and adaptability, while governance provides the necessary framework for transparent, ethical and responsible decision-making.

The research highlights several important conclusions:

- Sustainability has become a strategic necessity for SMEs and an important factor for maintaining long-term competitiveness.
- The integration of ESG principles improves operational efficiency, transparency and stakeholder trust.
- Circular economy practices contribute to resource efficiency and lower operational costs.
- Social sustainability strengthens organizational reputation and employee motivation.
- Sustainable governance supports adaptation to European sustainability standards and reporting requirements.

Recommendations include increasing access to green financing, promoting ESG education and managerial training, encouraging partnerships between SMEs and public institutions and implementing simplified sustainability reporting frameworks such as VSME.

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PROJECT APPROACH AS A TOOL FOR IMPROVING MARKETING MANAGEMENT EFFICIENCY

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Abstract: *This article examines the potential for applying a project-based approach within a company's marketing management system. The topic's relevance stems from the growing dynamism of the market environment, the digitalization of business, and the need to enhance the flexibility of marketing decisions. The traditional functional approach to organizing marketing is often insufficient for implementing complex initiatives that require cross-functional collaboration, adherence to deadlines, and resource control. The aim of the study is to develop a conceptual model of project-oriented marketing management and to justify its impact on improving marketing performance. The research employs methods of systems analysis, comparative analysis, structural modelling, and case study analysis. The author proposes a Project-Oriented Marketing Management (POMM) model, which includes operational, project, and portfolio levels of marketing management. A five-stage mechanism for implementing the model within a company has also been developed.*

Keywords: *marketing, project approach, marketing management, efficiency, project management, POMM, marketing projects*

JEL: M10, M15, M31, O32

Introduction

In the context of intense competition, accelerated digital transformation, and continuously evolving consumer behavior, companies need to adapt their marketing activities rapidly to changing market conditions. The traditional functional approach to marketing management, based on a stable distribution of responsibilities among departments, often proves insufficiently flexible for implementing complex marketing initiatives that require cross-functional collaboration, adherence to deadlines, budget control, and measurable results.

This is particularly evident in tasks such as launching new products, implementing integrated advertising campaigns, rebranding, entering new market segments, and introducing CRM systems and digital promotion channels. Such initiatives exhibit the key characteristics of projects: they are time-bound, aimed at delivering unique results, resource-constrained, and require coordination among multiple stakeholders. In this context, the importance of the project approach as a managerial tool is increasing, as it enables companies to improve the effectiveness of marketing activities, reduce the time required to implement initiatives, enhance process transparency, and ensure the achievement of strategic marketing objectives.

Despite growing practical interest in this topic, the issue of systematically integrating project management methods into marketing activities remains underexplored, underscoring the relevance of this study.

The aim of the research is to develop theoretical and practical foundations for applying the project approach within a company's marketing management system and to substantiate its impact on marketing performance.

The main hypothesis is that applying the project approach in marketing management enhances marketing effectiveness by improving process coordination, reducing implementation time, and increasing the performance of marketing initiatives.

The scientific novelty of the research lies in advancing approaches to marketing management through the integration of project management principles and in developing a model for the project-oriented organization of marketing activities.

Basic content

Theoretical Background of the Study

The theoretical framework of the study is grounded at the intersection of three areas of management science: marketing management theory, project management concepts, and modern approaches to organizational agility.

In contemporary research, marketing is viewed as a system for managing value creation for customers, shaping a company's market behavior, and developing long-term customer relationships. Significant contributions to this concept have been made by Philip Kotler, Kevin Lane Keller, and Christian Grönroos, who regard marketing as a strategic function of the company (Kotler & Keller, 2016; Grönroos, 2007).

Project management theory holds that a project is a temporary endeavour aimed at creating a unique product, service, or result. The Project Management Institute systematises this approach in the PMBOK Guide, which emphasises constraints related to time, cost, quality, and resources (PMI, 2021). In the digital economy, there is growing interest in flexible management approaches. Research on agile management shows that organisations increasingly rely on cross-functional teams, short execution cycles, and rapid hypothesis testing (Rigby, Sutherland & Takeuchi, 2016). Additionally, recent studies on digital transformation highlight that effective management requires integrating strategic, project, and operational approaches, as well as a high level of organisational adaptability (Verhoef et al., 2021).

The application of the project approach to marketing activities is addressed in the academic literature in a fragmented manner. Most studies focus either on general marketing management issues or on specific aspects of implementing marketing projects. Classical marketing research indicates that the effectiveness of the marketing function depends on a company's ability to adapt to changes in consumer demand, competition, and technology (Kotler & Keller, 2016). However, the traditional functional structure of marketing management does not always provide sufficient responsiveness to changes in the external environment.

From a project management perspective, many marketing initiatives exhibit all the characteristics of projects: they are time-bound, have a unique objective, require a defined budget, and involve the coordination of resources. This applies to product launches, advertising campaigns, rebranding efforts, market entry strategies, and digital transformation initiatives (PMI, 2021).

The concept of projectification, which reflects the growing role of projects in organizational activities, is increasingly discussed in the literature. According to Rolf A. Lundin and co-authors, modern organizations are progressively shifting from functional structures to project-oriented forms of work organization (Midler, 1995; Lundin et al., 2015). This is particularly relevant to marketing, where a significant portion of activities is carried out through temporary initiatives.

A number of studies focus on agile marketing as a related field. Darrell Rigby and co-authors argue that agile management practices enhance decision-making speed and improve cross-functional collaboration (Rigby et al., 2016). In marketing, this translates into faster testing of advertising hypotheses, rapid campaign adjustments, and improved accuracy of customer-focused decisions. However, the literature indicates that the systematic integration of the project approach into marketing management remains underdeveloped. Most authors examine individual projects rather than considering the marketing system as a whole as an object of project-based management.

Recent studies confirm the growing interest in integrating project management and marketing. For instance, Obradović et al. note that traditional project management does not sufficiently account for marketing orientation and customer value. Agile approaches are viewed as a mechanism for increasing organizational adaptability (Rigby et al., 2016), while recent research demonstrates the expansion of agile project management beyond the IT sector (Dong et al., 2024). Furthermore, Arne Naudé and Werner Wirtz emphasize that in the context of digitalization, marketing increasingly requires the integration of various management approaches, including project-based and process-based models, to enhance flexibility and efficiency (Wirtz & Daiser, 2018).

In this study, the project approach is proposed to be considered not only as a method for implementing individual marketing campaigns but also as a managerial model for organising marketing activities through a system of projects, programmes, and portfolios aligned with the company's strategic objectives.

Project-Oriented Marketing Management

Marketing should be viewed not only as a set of ongoing functions but also as an integrated system that combines two types of activities: regular processes and temporary projects. Dave Chaffey and Fiona Ellis-Chadwick note that digital marketing includes "ongoing, always-on communications and campaign-based activities," meaning it combines continuous processes with discrete projects (Chaffey & Ellis-Chadwick, 2022).

Therefore, the author proposes the Project-Oriented Marketing Management (POMM) model, in which marketing is understood as a system that integrates daily operations, individual project-based initiatives, and strategic management at the portfolio level.

Campaign launches, market entry, the implementation of new tools, and many other marketing activities are temporary and unique. Therefore, managing marketing solely as a continuous function is no longer sufficient—there is a need to combine processes and projects. The operational level includes daily, repetitive activities such as social media management, content creation, email marketing, advertising, analytics, and brand support. This level ensures the company's continuous market presence, customer interaction, and stable performance.

The project level of marketing management focuses on implementing temporary initiatives. These are tasks carried out once with a clearly defined objective, such as launching a new product, entering a new market, rebranding, implementing a CRM system, or executing a large-scale advertising campaign. Such initiatives are characterised by clear goals, time constraints, fixed budgets, dedicated teams, and a system of key performance indicators.

The third aspect of the model concerns managing all marketing projects as a unified system. Its purpose is to align individual projects with the company's strategy, allocate resources efficiently, and identify priority areas for marketing investment. At this level, economic efficiency is assessed (e.g., through ROI), results are monitored, and the project portfolio is revised as market conditions and company objectives change.

In the POMM model (*Figure 1*), the three levels: operational, project, and portfolio do not operate sequentially but are interconnected. Operational activities generate data on customers and the market, which underpin the launch of new projects. In turn, projects transform existing marketing processes and tools. The portfolio level allocates resources between ongoing operations and projects in line with strategic priorities. Market outcomes, such as sales, response rates, and KPIs, provide feedback for the entire system, indicating what works and what requires adjustment.

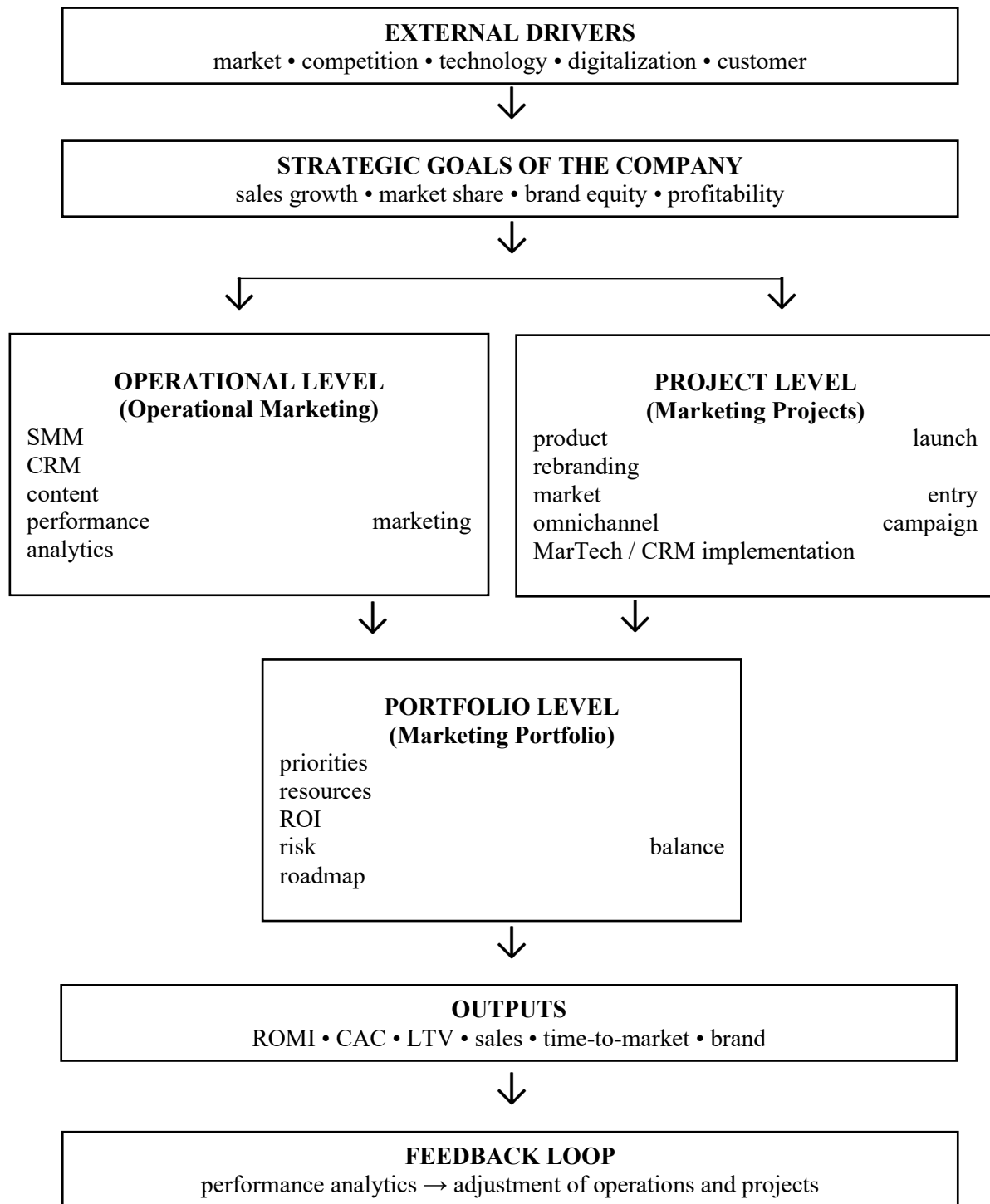


Figure 1. Project-Oriented Marketing Management

Source: developed by the author based on the analyzed literature

The implementation of Project-Oriented Marketing Management (POMM) in a company should be carried out in stages. This approach helps reduce organizational risks, facilitates staff adaptation to new working principles, and preserves the stability of existing marketing processes. A gradual implementation enables a smooth transition from traditional functional marketing management to a more flexible, project-oriented system without disruptive changes.

At the first stage, an analysis of the existing marketing management system is conducted. The goal of this stage is to identify the characteristics of current marketing processes and determine key

problems that hinder the effective implementation of marketing initiatives. The analysis includes the organizational structure, existing processes, campaign launch timelines, frequency of budget overruns, quality of interdepartmental interaction, distribution of responsibilities, and the level of achievement of marketing KPIs. As a result, key weaknesses are identified and areas for improvement are defined.

At the second stage, the company's marketing activities are classified into two main groups: operational processes and project initiatives. This classification is necessary to build a more transparent and effective management system. Operational processes include regular and repetitive activities such as social media management, content marketing, CRM communications, performance advertising, and ongoing analytics. These tasks are continuous and ensure the day-to-day functioning of marketing. Project initiatives, on the other hand, are temporary tasks with specific goals and defined timeframes, such as launching a new product, rebranding, entering a new market, implementing marketing technologies, or conducting a large-scale advertising campaign. This classification makes it possible to distinguish which activities require continuous management and which should be handled using project management methods.

At the third stage, the organizational and methodological infrastructure of project marketing is established. The company defines areas of responsibility, roles, and duties of employees, appoints project managers, and forms cross-functional teams involving marketing, sales, IT, and finance. At the same time, tools for scheduling tasks and resources are introduced, documentation, budgeting, and reporting formats are standardized, and digital management systems such as Asana, Trello, or Jira are implemented. As a result, this stage creates the managerial environment necessary for the effective functioning of the POMM model.

At the fourth stage, pilot marketing projects are launched. At this stage, the company tests the new management system on a limited number of initiatives, allowing it to assess the model's effectiveness without significant organizational risks. Pilot projects may include launching a new product line, a seasonal advertising campaign, CRM implementation, or a digital promotion program. This enables testing the model under real conditions. During implementation, factors such as task completion time, budget adherence, KPI achievement, team interaction, and decision-making speed are evaluated. The results help identify the strengths and weaknesses of the model and make necessary adjustments.

The fifth stage involves scaling the POMM model across the entire marketing system and transitioning to portfolio management of initiatives. After successful testing, the project approach is extended to all key areas of marketing activity. A unified portfolio of marketing projects is formed, within which initiatives are selected and prioritized in accordance with the company's strategic goals, resources are allocated, and expected returns and overall effectiveness are assessed. In addition, control over results is strengthened, and the overall contribution of projects to business objectives is analyzed. At this stage, the project approach becomes a stable element of the company's marketing management system.

The five-stage implementation of the Project-Oriented Marketing Management model ensures a gradual transformation of the marketing function, combining operational stability with increased flexibility, innovation, and strategic control. Despite the identification of five stages, they should not be viewed as a strictly linear sequence, but rather as an adaptive management cycle. The company may return to previous stages to refine processes, reallocate resources, and improve project mechanisms.

Conclusion

In the context of rapid market dynamics and digital transformation, the traditional functional approach to marketing management requires the integration of modern organizational tools. One such tool is the project approach, which structures marketing activities through a system of temporary initiatives aimed at achieving specific market outcomes.

This study develops an original Project-Oriented Marketing Management (POMM) model that integrates operational, project, and portfolio levels of marketing management. A five-stage mechanism for implementing the model in companies is proposed. Practical application demonstrates that the use of the project approach reduces the time required to launch marketing initiatives, minimizes budget deviations, and improves overall marketing performance. At the same time, coordination between departments is enhanced, making processes more consistent and manageable. Transparency of task execution increases, decision-making is accelerated, and control over marketing KPIs is strengthened. This allows for a more accurate evaluation of both individual initiatives and overall marketing effectiveness.

Thus, the project approach can be considered an effective tool for improving the marketing management system of a company, ensuring greater flexibility, control, and results orientation.

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THE ROLE OF HIGHER EDUCATION ATTAINMENT IN ECONOMIC DEVELOPMENT: EVIDENCE FROM THE REPUBLIC OF MOLDOVA

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Abstract: *This study examines the relationship between attainment of higher education and economic development in the Republic of Moldova amid demographic decline, population ageing, and labour migration. The main aim of the research is to identify whether an increase in the share of individuals aged 25 years and older possessing higher education contributes positively to GDP at purchasing power parity (PPP). The analysis is based on annual macroeconomic data for Moldova covering the period 2001–2024 obtained from the World Bank's World Development Indicators database and the International Monetary Fund. The empirical methodology relies on the Cobb–Douglas production framework estimated in logarithmic form, where GDP at PPP in constant 2021 international dollars depends on capital stock, labour input, and the share of the population aged 25 or older with higher education. Ordinary least squares (OLS) and two-stage least squares (2SLS) models are estimated in order to test for possible endogeneity of the educational attainment variable and to compare the consistency of the obtained estimates. The results demonstrate that capital accumulation remains the principal driver of economic growth in Moldova, while the share of the population with higher education has a positive and statistically significant effect on GDP at PPP for 2009–2024. Diagnostic procedures do not reveal significant econometric problems related to heteroskedasticity, autocorrelation, multicollinearity, wrong specification. The findings of weak instruments and Wu-Hausman tests suggest that despite demographic challenges and migration processes, the increasing share of the individuals with higher education contributes positively to Moldova's economic development.*

Key words: *higher education, economic growth, labour, capital stock*

JEL: F43, C22, C26, I25

Introduction

Population ageing, persistently low fertility rates, and large-scale labour migration have emerged as significant long-term constraints on economic growth in Central and Eastern Europe, particularly in post-socialist economies outside the European Union. In the Republic of Moldova, these demographic and social processes are accompanied by a steady decline in the working-age population, a rising demographic dependency ratio, and the ongoing emigration of highly qualified professionals. Under these circumstances, the ability of professional and especially higher education systems to adapt to evolving labour market needs becomes a critical determinant of economic competitiveness and sustained long-term growth.

Traditional economic growth models, such as the Keynesian Harrod–Domar model (Harrod, 1939; Domar, 1946) and the neoclassical Solow model (Solow, 1956), incorporated education only indirectly—primarily through aggregate investment and exogenous technological progress. In contrast, endogenous growth theories advanced by Romer (1990), Lucas (1988), and Uzawa (1965) highlight the direct role of human capital accumulation and education in fostering long-term economic expansion. According to human capital theory (Schultz, 1961; Becker, 1964), investment in education enhances labour productivity and contributes to higher national income. Nevertheless, empirical evidence on the effectiveness of public spending on education remains mixed, especially in former socialist European

countries (Coman et al., 2022), where institutional inefficiencies, labour migration, and structural mismatches between educational systems and labour-market demands are prevalent.

Studies focusing on post-socialist European countries reveal that the impact of public educational expenditure varies considerably across regions and institutional frameworks. While positive effects are more commonly observed in Western Europe, the relationship in Eastern Europe is often statistically weak or inconsistent (Gagauz & Samohvalov, 2024). Earlier empirical research for Moldova has even indicated a negative association between educational expenditure and GDP (PPP), a phenomenon attributed to migration, inefficient allocation of public resources, and problems with alignment between educational programs and labour market requirements (Gagauz & Samohvalov, 2024).

Despite high migration rates, a substantial portion of higher education graduates remain engaged in the Moldovan labour market. However, available official and survey-based data do not allow for a precise estimation of the proportion of graduates who remain in Moldova after earning their degrees. Against this background, the aim of this study is to quantitatively assess the role of the share of individuals aged 25 and older with at least a bachelor's degree among the total 25+ population in Moldova in the level of economic development.

Basic content

The empirical analysis in this study utilises annual macroeconomic data for the Republic of Moldova, spanning the period from 2001 onward. The choice of this observation window is primarily driven by data availability. Specifically, the key indicator reflecting the share of the population aged 25 years and older with higher (at least bachelor's degree) education is available for Moldova in the World Bank database only from 2000. Additionally, the dynamics of capital growth in the socialist period (with constant growth at 4% until 1990, followed by a steady decline in the 1990s) differ fundamentally from the steady capital growth experienced under market conditions in the 21st century, when 16 out of 19 years from 2001 to 2019 showed year-over-year increases in capital stock. Consequently, the effective estimation period begins in 2001.

For each linear regression model, natural logarithm of capital stock for the years 2020–2024 was forecasted using the Ordinary Least Squares (OLS) method for simple linear regression in Microsoft Excel, based on historical natural logarithm of capital stock data from 2001 to 2019.

The analysis draws on data from the International Monetary Fund (capital stock) and the World Bank's World Development Indicators (all other model variables). GDP at purchasing power parity (PPP) in constant 2021 international dollars is used as the dependent variable, as it reflects the scale of economic activity adjusted for price levels over time.

The empirical framework is based on the Cobb–Douglas production function:

$$Y=AK^{\alpha}L^{\beta} \quad (1)$$

where Y denotes output (in US dollars at 2021 PPP), K is capital stock (in US dollars at 2017 PPP), L is labour input, and A reflects the level of technological and human capital development. Labour input is calculated as the product of the population aged 15 and older and the labour force participation rate for that group (ILO estimates in the World Bank database), divided by 100.

A central focus of the study is the role of attainment of higher education in economic development. The variable $b25$ represents the share of individuals aged 25 and older with at least a bachelor's degree. The instrumental variable $b25\_1$ reflects the same indicator lagged by one year, allowing the analysis to test whether the attainment of higher education causally influences economic development rather than simply correlating.

The estimated regression specification is:

$$LN(Y) = \beta_0 + \beta_1 LN(K) + \beta_2 LN(L) + \beta_3 b25 + \varepsilon \quad (2)$$

where b25 equals LN(A) from the first equation. Estimation proceeded in stages: first, ordinary least squares (OLS) models were estimated; then, two-stage least squares (2SLS) was used to test the quality of the OLS model. The best-performing model for Moldova, summarised in Table 1, demonstrates a positive, statistically significant relationship between the share of the population with higher education and GDP at PPP, with high explanatory power and sound econometric properties.

Table 1. OLS estimation results for Moldova (2009–2024)

Country	LN(K)	LN(L)	share, 25+	ε	R-squared	Adj. R-squared	Number of observations
Moldova	2.2822**** (1.95*10 [^] (-5))	0.3634 (0.10163)	2.6379** (0.02126)	-37.554*** (0.00181)	0.9518	0.9398	16

****, ***, **, * denote significance at the 0.1%, 1%, 5%, and 10% levels, respectively.

Note: The table presents p-values in brackets.

Source: Calculated by the author

The results indicate that capital accumulation is the principal driver of economic growth in Moldova, as evidenced by the positive and highly significant coefficient associated with capital stock. Additionally, the proportion of the population aged 25 and older with higher education is positively related to GDP at PPP and is statistically significant at the 5% level. The labor variable also maintains the expected positive sign and approaches the conventional 10% significance threshold.

All estimated models were subjected to diagnostic tests for heteroskedasticity, autocorrelation, multicollinearity, and specification errors. These procedures did not reveal any statistically significant econometric issues, thereby confirming the reliability of the estimated models.

To assess whether the observed relationship between higher educational attainment and economic development reflects a causal effect, a two-stage least squares (2SLS) model was estimated, employing the lagged value of the educational attainment variable as an instrument. The results of this analysis are presented in Table 2.

Table 2. 2SLS estimation results for Moldova (2009–2024)

Country	LN(K)	LN(L)	share, 25+	ε	R-squared	Adj. R-squared	Number of observations
Moldova	2.2372**** (8.58*10 [^] (-5))	0.3607 (0.10483)	2.8056** (0.02126)	0.00471*** (0.04041)	0.9517	0.9396	16

****, ***, **, * denote significance at the 0.1%, 1%, 5%, and 10% levels, respectively.

Note: The table presents p-values.

Source: Calculated by the author

The 2SLS estimates remain very close to the OLS coefficients, supporting the consistency and robustness of the obtained estimates. The coefficient associated with attainment of higher education remains positive and statistically significant after instrumenting the variable. The validity of the instrumental variable was additionally evaluated using Weak Instruments and Wu–Hausman diagnostic tests, the results of which are reported in Table 3.

Table 3. Diagnostic tests for the 2SLS model

Country	Weak instruments	Wu-Hausman
Moldova	0.000365****	0.8234

****, ***, **, * denote significance at the 0.1%, 1%, 5%, and 10% levels, respectively.

Note: The table presents p-values.

Source: Calculated by the author

Overall, the findings suggest that despite demographic challenges and migration processes, the increasing share of individuals with higher education contributes positively to Moldova's economic development for 2009-2024. These findings suggest that the OLS estimates are consistent and unbiased.

Conclusions

The results of this study demonstrate that the share of the population aged 25 years and older with higher education has a statistically significant positive relationship with GDP at purchasing power parity in the Republic of Moldova during the period 2009–2024. The estimated Cobb–Douglas–type models indicate that capital accumulation remains the principal driver of economic growth, the labour variable maintains a positive sign but shows comparatively lower statistical significance, which may reflect the ongoing influence of demographic decline and migration on Moldova's labour market.

The estimated models successfully pass tests for heteroskedasticity, autocorrelation, multicollinearity, specification correctness, and weak instruments. In addition, the Wu–Hausman test indicates that the educational attainment variable is not statistically endogenous, supporting the consistency and reliability of the OLS model's estimates.

The positive coefficient associated with the attainment of higher education does not imply that public investment in higher education in Moldova is fully efficient. Previous studies frequently identified relatively weak or even negative relationships between government expenditure on education and economic growth. Nevertheless, the current results suggest that an increase in the share of highly educated individuals contributes positively to economic development, as workers with higher education exhibit higher productivity, adaptability, and innovative potential. This study contributes to the literature by re-evaluating the relationship between higher education and economic growth in Moldova, and may inform future improvements to the higher education system in light of expected demographic changes.

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SUSTAINABILITY MANAGEMENT IN RENEWABLE ENERGY PROJECTS

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Abstract: *This paper analyzes the critical role of renewable energy in the context of the global transition toward a sustainable development model, given that fossil fuels still account for 81% of global consumption, posing major climate risks. The study shows a positive trend at the European Union level, where clean energy sources reached a share of approximately 47% of electricity production in 2025, with the wind and solar sectors being the main pillars of this progress. Beyond environmental benefits, renewable energy projects are presented as essential economic drivers that stimulate innovation, create jobs, and strengthen energy independence. Particular attention is given to the management of these projects, an area marked by high complexity due to capital intensity and regulatory uncertainties. Modern management in this sector must be adaptive, integrating digitalization, risk analysis, and green financing mechanisms to ensure long-term viability. Finally, the analysis focuses on the Republic of Moldova, where, despite financial constraints and dependence on imports, alignment with the policies of the European Energy Community opens new prospects for investment. The success of these initiatives depends on managers' ability to balance technological efficiency with social acceptance and economic sustainability, thereby providing a clear path toward a resilient and competitive energy future.*

Key words: *renewable energy, sustainability, renewable energy projects, sustainability management.*

JEL: Q01, Q4, Q42.

Introduction

The global energy transition is undoubtedly the greatest structural challenge of the 21st century. In a world marked by an ever-growing demand for energy and the looming threat of climate change, the paradigm based on finite and polluting resources has become unsustainable. Today, energy is no longer viewed merely as a technical resource necessary for the functioning of the economy, but as a central pillar of national security and social equity. The shift toward renewable sources entails not only a change in technology, but a profound reconfiguration of how communities plan their long-term future.

Within this rapidly changing landscape, the success of green initiatives does not depend solely on a region's natural potential or technological advancement, but, crucially, on the quality of project management. The complexity of this field stems from the need to balance massive capital investments with high market volatility and regulatory frameworks that are constantly evolving. In this way, renewable energy project management becomes a frontier discipline, where environmental sustainability must harmoniously align with economic viability and social acceptance. This paper explores the mechanisms underpinning the development of the energy sector, analyzing how

innovative managerial approaches can transform current constraints into opportunities for resilient growth, while also providing an overview of efforts to align with international standards within specific economic contexts.

The Context of Renewable Energy Development

Currently, the development of the global economy depends directly on the availability of energy resources, which play a significant role in raising society's level of development (Kotb et al., 2024). Population growth and the expansion of industrial activities are driving a steady increase in energy consumption, estimated at approximately 1.8% annually (Çelikkilek and Tüysüz, 2016). In this context, many countries are focused on identifying alternative solutions to address the challenges related to energy supply (Almutairi et al., 2022).

Traditional fuels continue to dominate global consumption, accounting for approximately 81% of the total energy used worldwide (Abo-Zahhad et al., 2024). However, their use is increasingly contested due to their negative environmental impact, contribution to climate change, and harmful effects on human health (Hosseini Dehshiri and Amiri, 2023). In response, many countries are directing significant investments toward the development of sustainable, low-carbon energy sources (Mostafaeipour et al., 2022).

In this context, renewable energy is considered a viable solution for meeting the growing demand for energy, offering the advantage of reducing environmental impact and helping to replace fossil fuels (Hosseini, Amiri, and Hosseini, 2024; Hao, 2022). It can be defined as energy derived from natural resources that have the capacity to regenerate at a faster rate than consumption, with the main sources being solar, wind, hydroelectric, geothermal, and biomass energy (Kage, 2023). The development of this sector has experienced rapid growth, with estimates indicating an increase in renewable energy consumption from 42 EJ in 2000 to approximately 247 EJ in 2050, highlighting the strategic importance of this field (Hosseini et al., 2024).

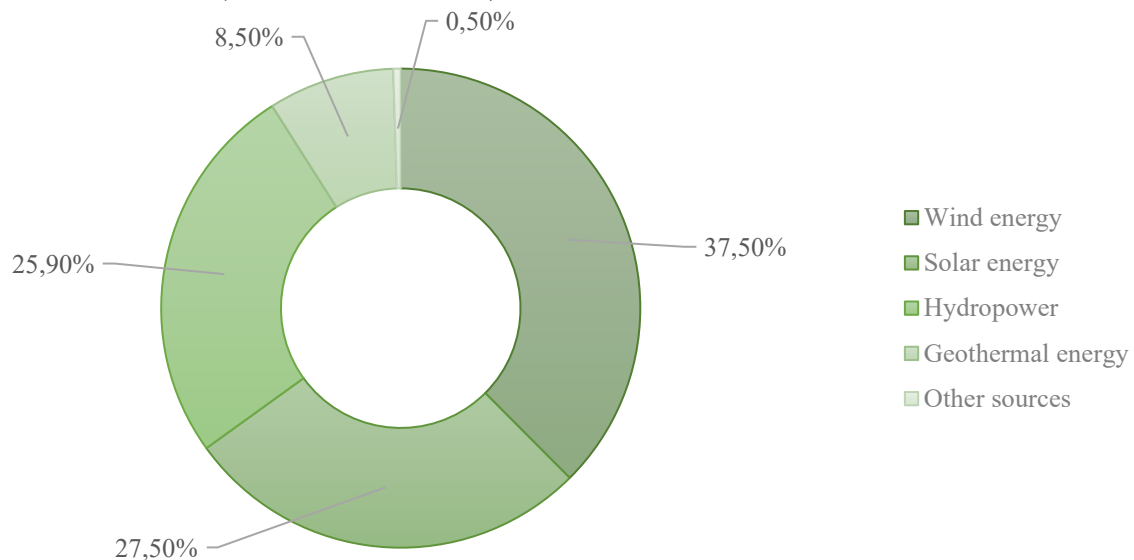


Figure 1. Share of renewable energy sources in electricity generation

Source: Prepared by the author based on Eurostat (2026)

At the European Union level, the share of renewable energy in electricity production has shown a positive trend. Thus, in 2025, approximately 47.3% of the electricity produced in the European Union came from renewable sources, a slight increase from the 47.2% recorded in 2024. The internal structure of this energy mix shows that wind energy accounts for the largest share (37.5%), followed by solar energy (27.5%) and hydropower (25.9%), while renewable fuels contribute 8.5%, and

geothermal sources and other forms of energy by approximately 0.5% (Eurostat, 2026). Thus, renewable energy is emerging as an essential solution for reducing dependence on fossil fuels and promoting sustainable development globally.

The sustainability of renewable energy projects

Renewable energy projects have become essential drivers of societal development and progress (Ruotsalainen et al., 2017). These initiatives make a significant contribution to addressing issues related to climate change, environmental degradation, and the depletion of non-renewable energy resources. By utilizing renewable sources such as wind, solar, hydroelectric, and geothermal energy, they offer cleaner and more sustainable alternatives to conventional energy sources. Furthermore, they support energy independence, reduce greenhouse gas emissions, and mitigate the negative impact of fossil fuel consumption (Hussain, Wang, and Benqian, 2023). At the same time, renewable energy projects contribute to economic growth by creating jobs, attracting investment, and stimulating technological innovation. They strengthen energy security, as they are less vulnerable to supply disruptions and price volatility associated with traditional energy sources. Overall, these projects offer not only a sustainable solution to meet energy demand but also a clear path toward a greener and more resilient future for society (Potocnik, 2007; Hussain, Wang, and Benqian, 2023).

These energy projects are closely linked to all dimensions of social development, namely social, environmental, and economic factors (Marques, Fuinhas, and Manso, 2010; Hussain, Wang, and Benqian, 2023). Sustainability in renewable energy projects is considered essential for ensuring continued economic growth and supporting social development in a balanced manner (Hussain, Wang, and Benqian, 2023). Furthermore, the concept of sustainability in the energy sector has gained greater international recognition amid shifts in consumption patterns and lifestyles (Becken, Frampton, and Simmons, 2001).

Sustainability within these projects aims to ensure the continued positive impact of organizations and programs, even after the project itself has been completed. Although a project is, by its nature, of limited duration, its effects should be maintained and leveraged thereafter (Hussain, Wang, and Benqian, 2023).

Management of Renewable Energy Project

The management of renewable energy projects has evolved into a highly dynamic and complex field, shaped by technological innovation, regulatory frameworks, and increasing sustainability requirements. Recent studies emphasize that renewable energy project management requires integrated approaches that combine technical, financial, and environmental considerations within a coherent strategic framework (Podbregar et al., 2022; Osuma and Yusuf, 2025).

At the firm level, enterprises implementing renewable energy projects must develop advanced managerial capabilities to cope with uncertainty and rapid market changes. These projects are characterized by high capital intensity, long payback periods, and strong dependence on policy support mechanisms. Consequently, firms increasingly rely on adaptive management and dynamic capabilities to ensure project viability and long-term competitiveness (Losada-Agudelo and Souyris, 2024; Teece, 2025).

A central feature of renewable energy project management is the integration of sustainability principles across the entire project lifecycle. Recent literature highlights that sustainable project management extends beyond environmental concerns to include social acceptance and economic viability, forming a multidimensional framework for decision-making (Sabini, Muzio and Alderman, 2019; Podbregar et al., 2022). This integrated perspective is essential in the renewable energy sector, where projects often face trade-offs between efficiency, cost, and environmental impact.

Stakeholder management represents another critical dimension. Renewable energy projects involve multiple actors, including governments, local communities, investors, and technology providers. Recent empirical studies demonstrate that stakeholder engagement and social acceptance significantly influence project success, particularly in decentralized and community-based energy

systems (Segreto, 2020; Wolsink, 2020). In this context, transparent communication and participatory approaches are increasingly recognized as best practices.

Risk management is also a defining component of renewable energy project management. Compared to conventional energy systems, renewable energy projects face higher levels of uncertainty due to variability in resource availability, evolving regulatory frameworks, and market fluctuations. Recent studies emphasize the importance of integrated risk management frameworks that combine technical forecasting with financial and policy risk assessment (Zhou et al., 2025; Su et al., 2026).

Financial management remains a major challenge, particularly for small and medium-sized enterprises. The high upfront costs of renewable energy technologies require access to external financing, while revenue streams are often dependent on long-term contracts and policy incentives. Recent research highlights the growing importance of innovative financing mechanisms, including green finance instruments and public-private partnerships, in supporting renewable energy investments (Polzin et al., 2019; Osuma and Yusuf, 2025).

Digitalization is increasingly transforming the management of renewable energy projects. The adoption of smart grids, data analytics, and artificial intelligence enables improved forecasting, operational efficiency, and real-time decision-making. These technologies support more effective integration of renewable energy into existing systems and enhance overall project performance (Podbregar et al., 2022).

In the context of the Republic of Moldova, renewable energy project management is influenced by structural constraints, including limited financial resources, regulatory volatility, and dependence on energy imports. However, recent policy developments aligned with European energy strategies have created new opportunities for investment, particularly in solar energy projects. Enterprises operating in this environment tend to adopt conservative management strategies, focusing on risk minimization, cost control, and gradual investment approaches (Energy Community, 2024).

Overall, the management of renewable energy projects requires a multidimensional and adaptive approach that integrates sustainability principles, stakeholder engagement, risk management, and financial innovation. The ability of firms to effectively manage these dimensions is essential for ensuring both project success and long-term competitiveness in an increasingly complex energy landscape.

Conclusions

An analysis of the renewable energy sector's development highlights the fact that the energy transition is no longer merely an environmental choice, but has become a global economic and strategic imperative. The shift from fossil fuels to renewable sources is essential to meet the constant growth in energy demand and to mitigate the negative impact on the climate and human health. The positive developments within the European Union, where green sources are projected to account for nearly half of electricity production by 2025, demonstrate the viability of this development model.

The success of renewable energy projects fundamentally depends on integrating the three pillars of sustainability: economic, social, and environmental. These initiatives not only reduce greenhouse gas emissions but also stimulate economic growth by creating jobs, attracting investment, and strengthening energy security. To ensure a positive long-term impact, sustainability must remain a priority even after the construction phases of the projects are completed.

Ultimately, the management of these projects is the key factor in transforming natural resources into sustainable economic value. In a sector marked by volatility and technological complexity, success depends on companies' ability to adopt adaptive strategies, integrate digitalization, and effectively manage financial risks and stakeholder relationships. Even in contexts with limited resources, such as that of the Republic of Moldova, alignment with European policies and the adoption of modern management practices offer a clear path toward a resilient, green, and competitive energy future.

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ANALYSIS OF THE REVEALED COMPARATIVE ADVANTAGE (RCA) OF MOLDOVAN HORTICULTURAL PRODUCTS ON EXTERNAL MARKET

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Abstract: *The horticultural sector has a vital role in the economy of the Republic of Moldova due to its important share in the agricultural output and contribution to exports. The paper aims to quantify the international competitiveness of Moldovan horticultural products (vegetables, nuts and fruits) on the external market through the RCA index. Calculations were based on the Balassa's standard RCA formula and the export data retrieved from the World Integrated Trade Solution (WITS) database for the period 2020–2024. The findings reveal a strong and stable comparative advantage in several high-value categories like walnuts, fresh grapes, apples, plums, and sour cherries, while promising growth is noted for carrots, onions, hazelnuts, and some berries. These results demonstrate Moldova's specialization in traditional fruit and nut production based on the accumulated expertise and recent investments in intensive orchards. The paper concludes with recommendations intended for the consolidation of the existing advantages and addressing constraints related to perishability, quality standards, and market diversification.*

Key words: *Revealed Comparative Advantage, horticulture, fruits, nuts, vegetables, Moldova, competitiveness*

JEL: F14, Q17

Introduction

The agricultural sector of the Republic of Moldova represents an active and dynamic sector, being in a continuous process of transformation and modernization, playing a significant role in the socio-economic development of the country by providing the rural population with jobs, ensuring food security (Stratan et al, 2023), primarily at the family level, but also with an expansion to higher levels (local, regional and even national), as well as through the important export quantities of raw and processed products of agricultural origin (Lucasenco & Ceban, 2025).

At the same time, the horticultural sector is an essential element of the agricultural sector in particular (Iașișin, 2024), but also of the economy of the Republic of Moldova in general, and together with cereal crops (wheat and corn), oilseeds (sunflower and rapeseed) and alcoholic products (wines), horticultural products, especially fruits, occupy a significant share in the total value of agricultural production, also holding an important share in the export of agri-food products of the Republic of Moldova. The role of this sector is not only to generate profit for entrepreneurs, but also to create added value throughout the entire value chain (Golban, 2014; Stratan et al, 2014; Iașișin, 2025), with increases in the value of production, new jobs, additional income, but also of the international recognition through recognized products, the country brand and the quality of the products.

Exports of Moldovan fruits on the foreign market are of particular importance, due to their significance in the export potential of the country (Fala & Fala, 2025; Lucasenco & Ceban, 2022). At the same time, they are mostly placed in the top five most exported Moldovan-origin products on the external market (Stratan & Lucasenco, 2022).

At the national level, the topic of the horticultural sector has been addressed by several experts in various contexts and forms. A strictly sub-sectoral approach, at the product level (apples, cherries, plums, nuts, etc.) is noted in the works of Ceban & Lucasenco (2021), Ceban & Lucasenco (2023), Iașișin (2022), Turețchi & Ceban, (2022). Aspects related to the modernization of the horticultural

sector, especially the fruit sector, can be found in the works of Turețchi (2025), Balan (2023), and aspects related to competitiveness were addressed by Litvin & Dobrovolschi (2015), Golban & Gorgos (2017), Zbancă et al (2017). Furthermore, the educational and quality management context was researched by Bălan et al (2025) and Litvin & Zbancă (2025). The Revealed Comparative Advantage (RCA) approach in order to assess the competitiveness of horticultural products with respect to the world market was analyzed by Stratan et al (2023). The work includes calculation of RCA for all agri-food products, including fruits at 2-digit level. The same approach was found in the work of Lucasenco & Ceban (2020) but in the framework of the regional level, with comparisons between Moldova, Romania and Ukraine. With respect to EU countries, RCA at the 2-digit level was calculated in the work of Cimpoiș and Sarbu (2020).

Even if the scientific literature with respect to the horticultural sector of Moldova is a comprehensive one, with in-depth analysis and various approaches, it still lacks some updated data on the RCA, especially at the 6-digit level. Specifically, this gap is going to be addressed by the author in this scientific study.

Therefore, the aim of the paper is to quantify the international competitiveness of Moldovan horticultural products (vegetables, nuts and fruits) on the external market through the RCA index.

In order to calculate the RCA for Moldovan horticultural products with respect to the world, the standard formula of RCA (Balassa, 1965) was used:

$$RCA_{MDA} = \frac{\frac{X_{MDA\_p}}{X_{MDA\_total}}}{\frac{X_{world\_p}}{X_{world\_total}}} \quad (1)$$

Where:

X_{MDA_p} – Moldova's exports of the product p

X_{MDA_total} – Moldova's total exports of goods

X_{world_p} – World total exports of the product p

X_{world_total} – World total exports of goods

If RCA value > 1, then Moldova has a comparative advantage in the product p with respect to the world.

The data for carrying out the calculations of the RCA were retrieved from the WITS database (2026) and covers the period 2020 – 2024. The relatively concise period of 5 years is explained by the most recent changes that take place in the agricultural sector of the Republic of Moldova, mostly the ones related to climate change impact, selection of different varieties of fruits and vegetables for planting etc.

Basic content

Production of *vegetables* in Moldova is of most importance for ensuring the food security, due to the population dietary needs in fiber and vitamins for a better nutrition and wellbeing of the human body (Zbanca et al, 2025).

Thus, RCA values for Moldovan *potatoes and tomatoes* are quite moderate compared to other horticultural products, with some notable differences between them. Only in 2021 potatoes registered values greater than 1, while in other years, all the value were indicating on the lack of competitiveness on the international market. Tomatoes have values close to 0 during the 5-year period. Therefore, the produced potatoes and tomatoes are mostly intended for the local consumption, with small amounts directed to export to other countries. The existing competitiveness for Moldovan tomatoes on the foreign market from Spain or Turkey, seasonality of products, as well as the technological limits point on a weak position for Moldova in the global chain of tomatoes (Figure 1).

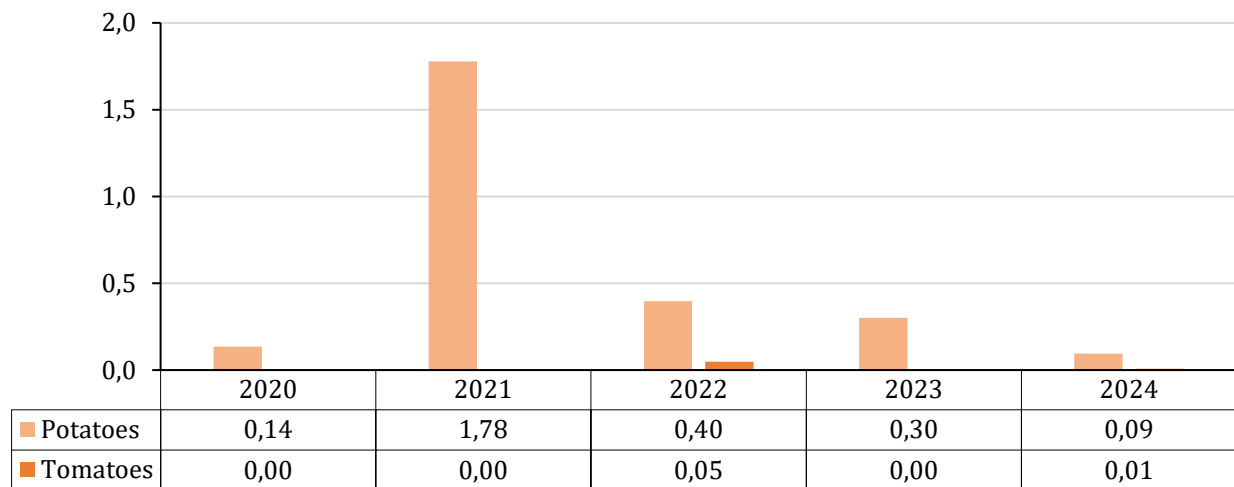


Figure 1. RCA for potatoes and tomatoes with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

For *onion and garlic*, Moldova is mostly competitive in onion, with RCA values higher than 1 starting with 2021. The maximum value for Moldovan onion was reached in 2023 (4.9), while in 2024 it reached 3.6. Garlic has 0 values in most of the analyzed years, with a small increase up to 0.1 in 2024. Thus, the difference between these two products is quite notable. On the international markets, garlic is facing a strong competition from China, while at the national level, there are still low product quantities and high costs for production (Figure 2).

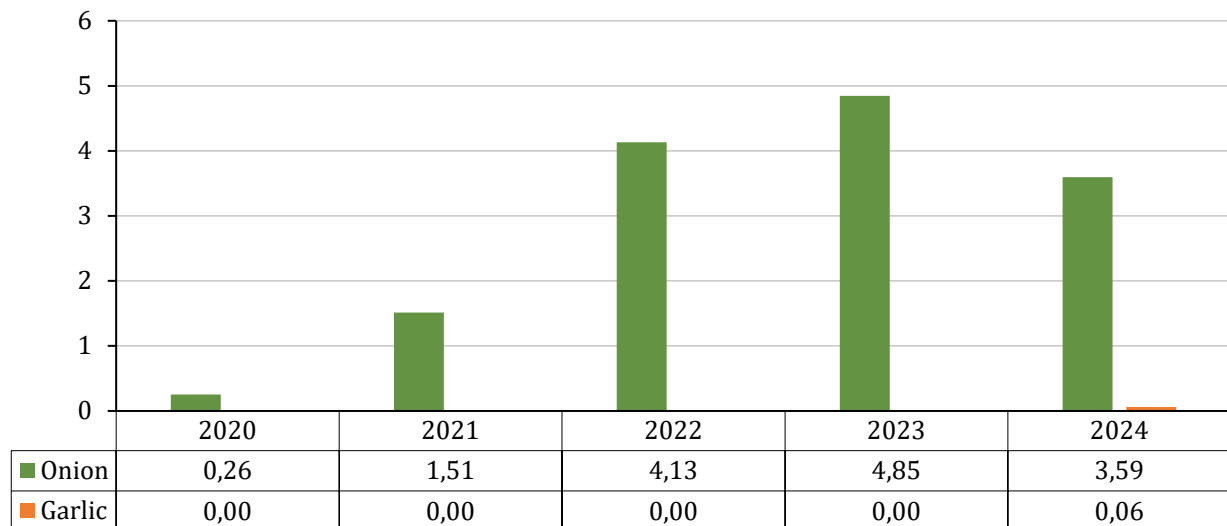


Figure 2. RCA for onion and garlic with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

Carrots, on the other side, register an impressive and steady growth, going from 0.32 in 2020 to values higher than 4–7 in the following years, indicating a clear specialization in growth. *Cabbage* also presents a positive, but less impressive evolution of the RCA value, reaching 2.8 in 2024. At the same time, other vegetables like cucumbers, beans and peppers are on the lowest side, with values close to 0. The high perishability of these products, their seasonality together with competition from other more specialized countries determine a lack of comparative advantage on foreign markets (Figure 3).

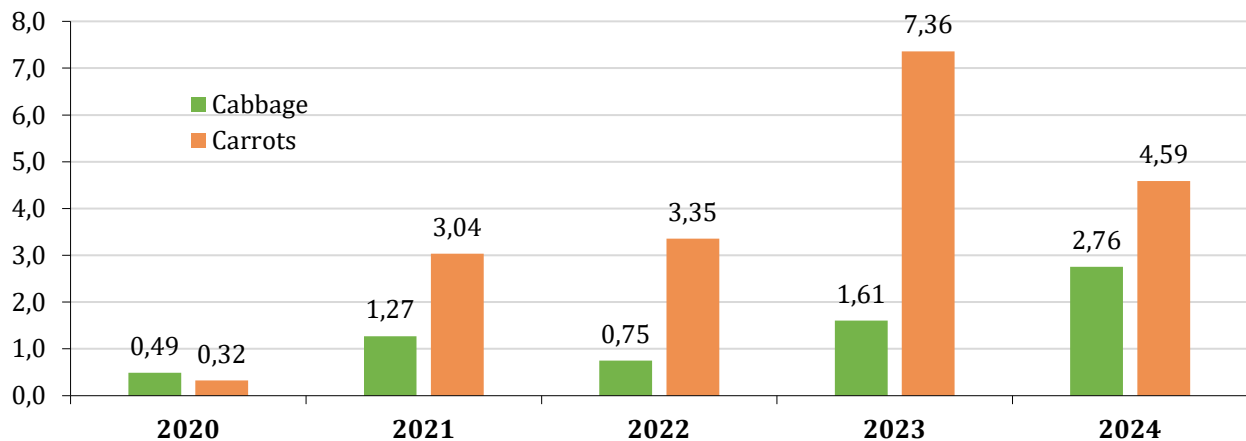


Figure 3. RCA for cabbage and carrots with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

From the economic point of view, the development of the vegetable production may lead to the further diversification of export destinations, but in order to increase the competitive advantage in some products or to consolidate it in others, there is an obvious need to improve the quality of production, increase the quantities, and invest in packaging and cold logistics.

The *nut* growing sector is one of the most ascending sub-sectors of Moldovan horticulture (Zbanca et al, 2020), with walnuts being among the most valuable products. Thus, the peeled common walnuts register extremely high RCA values reaching 267 in 2020, and remaining consistently in the range of 95–139 in the following years. Hazelnuts in shell are also on a growing path, reaching 32 in 2023, and walnuts in shell also present solid values of RCA between 5 and 17. Nevertheless, almonds show quite low RCA figures, having a limited competitiveness compared to other products in the same category of nuts (Figure 4).

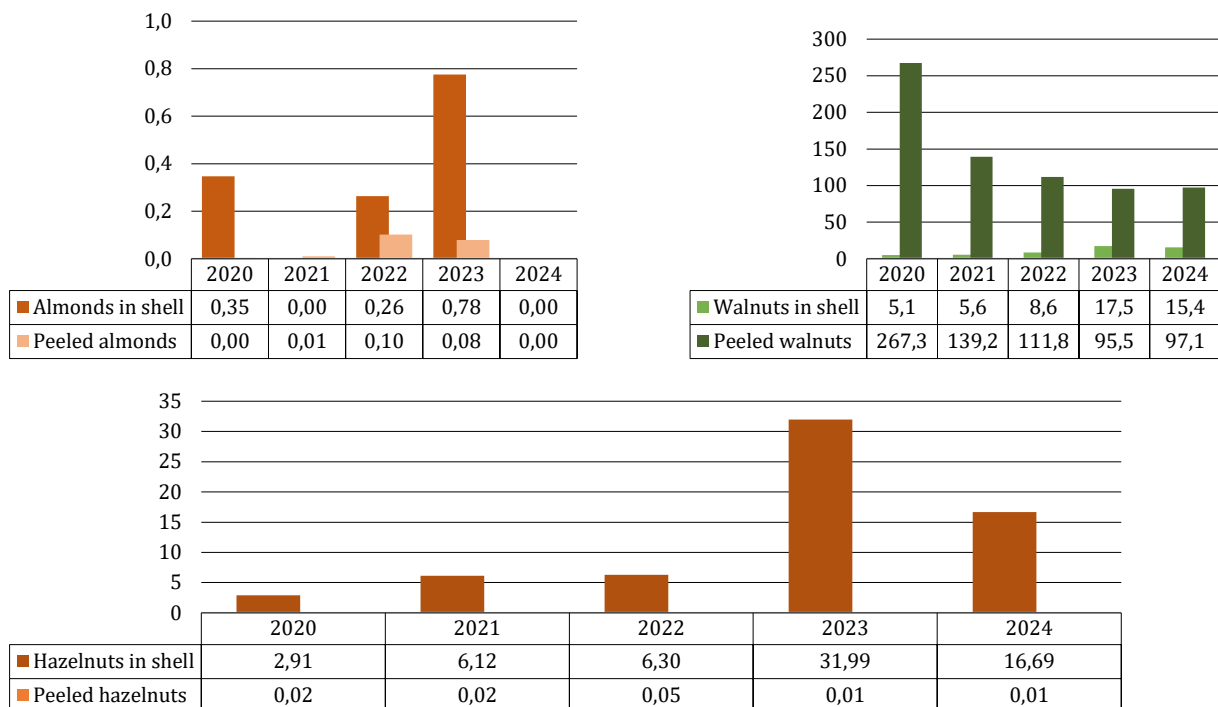


Figure 4. RCA for various types of nuts with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

Taking into account that Moldova is a large walnut producer, together with the increasing global demand for walnuts as a healthy food, the massive comparative advantage in peeled walnuts results from low labor costs, but also their good quality. At the same time, the growth in hazelnuts points on the diversification of nut plantations and some doses of adaptation of producers to the requirements of modern markets. The nut sector has positive effects on the rural economy and also on the trade balance, placing Moldova in the position of a competitive supplier of walnuts and hazelnuts, that has some stability and high performance in the sector.

In the long term, the accumulated experience in nut production, the traditional specialization and the climate conditions will be the most important determinants for enhancing the comparative advantage in this sector. The focus could be placed on support of the secondary processing and obtaining international certifications that will contribute to an increased added value in this area.

Another tradition in Moldovan agricultural sector is cultivation of *grapes*, mostly intended for production of wine, but also for the consumption. Therefore, fresh grapes present constantly high RCA values ranging between 20 and 38, with a slight increase in the last 2 years, while dried grapes have values between 0 and 0.3, pointing on a lack of competitiveness (Figure 5).



Figure 5. RCA for grapes with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

Generally, the grape growing sector or viticulture represents a historical legacy of the Moldovan agricultural sector. The sector has important links with the wine industry, but also with tourism in rural areas. Good soils and climate conditions have favored the cultivation of grapes, while the improved access to the EU market through the DCFTA has enhanced the orientation of grapes producers towards higher quality table grapes demanded by the EU market.

The *fruit* sector of Moldova is also based on tradition and specialization.

Among the analyzed *pome fruits* (apples, pears and quinces), *apples* dominate the group with high and relatively stable RCA values ranging between 52 and 75 during 2020 – 2024. *Quinces* have also a comparative advantage reflected through RCA between 1.7 and 13.1, while *pears* are under 1 (Figure 6).

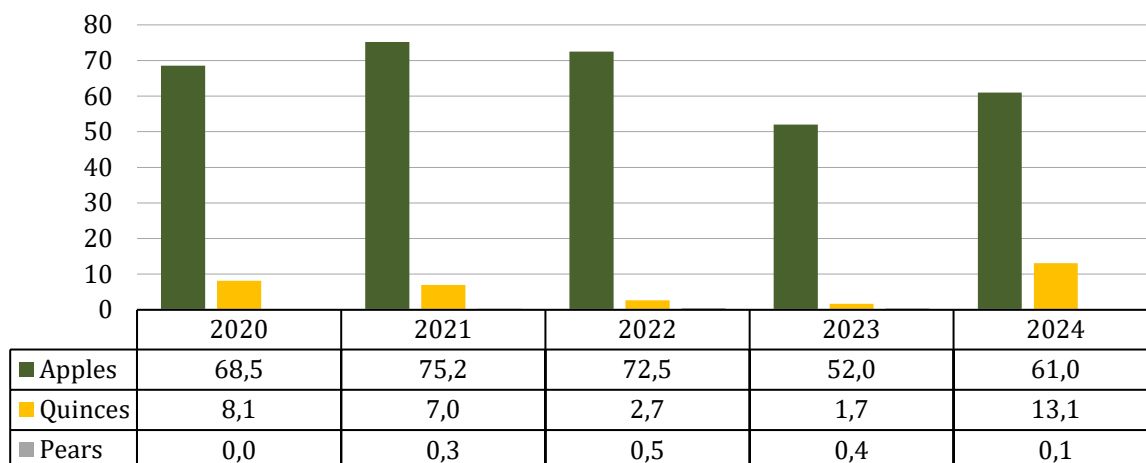


Figure 6. RCA for apples, quinces and pears with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

The most recent evolutions in the apple sector have had a positive impact on the RCA values. Large investments in intensive and high-intensive orchards, adapted varieties, well-established association process in the sector and large export networks give a dose of stability and resilience of the high RCA even in the conditions of the current external shocks. Nevertheless, for a better integration in foreign markets, it is advisable the continuous modernization of plantations, investments in post-harvest infrastructure and a diversification of the export destinations toward West countries, Middle East, South Asia, etc.

In the group of *stone fruits*, all the analyzed products present highly competitive degree on the international market. Thus, RCA for plums varies between 80 and 204, for sour cherries – between 72 and 218, for apricots – between 14 and 118, for cherries – between 7 and 29 and for peaches – between 3 and 6 (Figure 7).

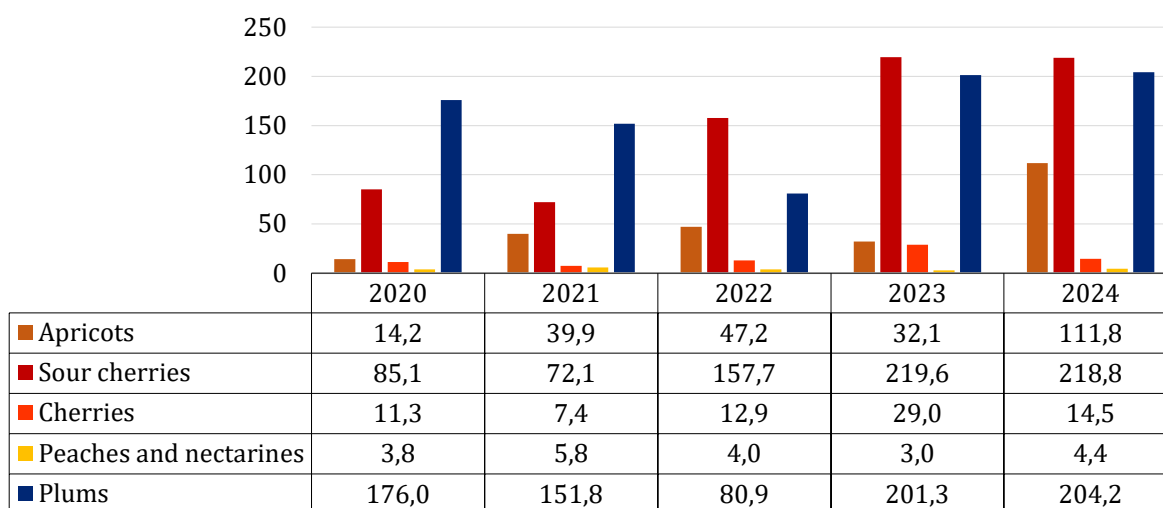


Figure 7. RCA for apricots, sour cherries, cherries, peaches and nectarines and plums with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

The investments in intensive plantations, storage facilities and refrigeration infrastructure have amplified the comparative advantage of Moldovan stone fruits on external markets. The spectacular growth in sour cherries reflects the export orientation to the EU market as a result of adoption of international quality standards and modern technologies. In the future, the sector would benefit from

diversifying varieties, expanding processing capacities and investing in national branding, to transform the current comparative advantage into a sustainable competitive advantage on longer value-added chains.

As for some *berries*, like strawberries, raspberries, mulberries, blackberries, currants and gooseberries, RCA values are generally higher than 1, with some volatility in the last 3 years for currants and gooseberries (Figure 8).

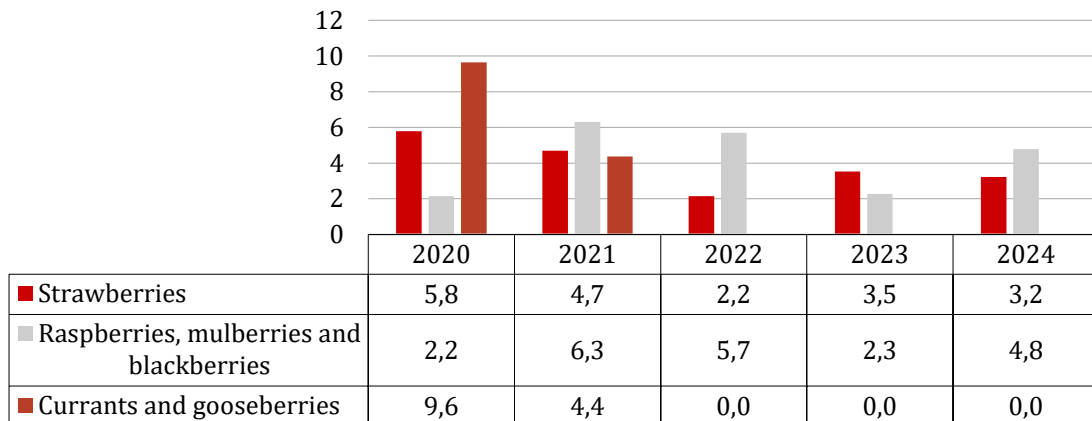


Figure 8. RCA for strawberries, raspberries, mulberries and blackberries and currants and gooseberries with respect to world, 2020 – 2024

Source: author's calculations based on WITS (2026)

These figures may indicate on an expansion of berries production and a more pronounced export orientation. The increase in RCA for selected berries can be associated with investments in modern technologies like greenhouses and irrigation, and also the improved quality of products. Nevertheless, the still moderate levels of RCA suggest the existence of some constraints like the perishability of the products and the need for an efficient cold chain. Therefore, although there is potential for growth, Moldova's comparative advantage in the case of berries remains in a phase of consolidation.

Conclusions

The analysis of the RCA for Moldovan horticultural products confirms that this sector is one of the most competitive segments of the Moldovan economy on the foreign market, as Moldova holds a clear and quite strong comparative advantage in some traditional products, particularly walnuts, grapes, apples, plums, sour cherries, and apricots. All of these products consistently record RCA values higher than 1, and in some cases above 50 or even 100, pointing on a deep specialization and orientation to export. Some positive dynamics were also recorded in carrots, onions, hazelnuts, and several berry species.

At the same time, the analysis reveals important weaknesses in other segments. Products such as tomatoes, potatoes, garlic, pears, and dried grapes show limited or no comparative advantage on the global market.

Overall, the horticultural sector demonstrates significant resilience and export potential. However, the existing comparative advantages are not yet fully transformed into sustainable competitive advantages. In order to consolidate and further develop the identified comparative advantages, the following measures are recommended:

- Investments in the post-harvest infrastructure, especially for perishable products (berries, stone fruits, vegetables). This will contribute to reduce losses and extend the market reach.
- Promotion of product diversification and value addition of products. Secondary processing support and encouragement of the development of organic and GI certifications will increase the added value of the sector.

- Diversification of export markets. This will reduce the dependence on traditional destinations by actively promoting Moldovan horticultural products in Western Europe, the Middle East, South Asia, and East Asia.
- Enhancement of quality of products and investments in research and innovation. The continuous modernization of plantations with an emphasis on innovations, digitalization and new varieties together with strengthened education and extension services in fruit growing and post-harvest technologies will bring additional benefits for the sector.

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APPLICATION OF THE IMPLICIT ASSOCIATION TEST IN EVALUATING EMOTIONAL AND RATIONAL BANKING ADVERTISING

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Abstract: *The complexity of financial services and increasing competition in the banking sector create the need for more effective approaches to evaluating advertising communications. In this context, neuromarketing methods are becoming increasingly relevant, as they allow the analysis of implicit consumer reactions that cannot always be identified through traditional survey and self-report methods.*

This article examines the application of the Implicit Association Test (IAT) for evaluating emotional and rational banking advertising. The aim of the study was to identify differences in the formation of consumers' implicit associations under the influence of different types of advertising stimuli related to a banking card.

The practical significance of the study lies in demonstrating the potential of implicit methods for pre-testing advertising materials, improving the effectiveness of marketing communications, and providing a deeper understanding of advertising perception mechanisms in the banking sector.

Key words: *neuromarketing, banking advertising, Implicit Association Test, IAT, consumer behavior, emotional advertising, rational advertising, implicit associations, advertising perception.*

JEL: M31, M37, G21

Introduction

Financial services belong to the category of complex and intangible products, the perception of which is largely determined by the level of trust, the feeling of security, and the subjective perception of risk. Unlike physical goods, banking products cannot be physically evaluated before their actual use, which makes emotional and cognitive perception mechanisms especially important in the decision-making process. In this context, neuromarketing serves as an effective tool for analyzing unconscious consumer reactions and provides a deeper understanding of the mechanisms underlying attitudes toward banking products and communications (Zubareva, 2025).

Neuromarketing offers an alternative approach to studying consumer behavior based on the analysis of hidden emotional and cognitive processes that directly influence customers' financial decisions (Morin, 2011).

Advertising is one of the key areas of marketing in which neuromarketing is actively applied (Ariely & Berns, 2010; Lee et al., 2007). In the banking sector, advertising communications perform not only an informational function, but also contribute to building trust, reducing perceived risk, and strengthening the perceived value of financial products in the minds of consumers.

In this context, neuromarketing becomes an important tool for evaluating advertising effectiveness by identifying which visual, auditory, and textual elements truly attract attention and create positive consumer perception. Understanding consumers' emotional and cognitive reactions makes it possible to create more persuasive and relevant advertising messages, as well as to test advertising materials before their launch (Afsar, 2014; Genco, 2013).

Popularity of Search Queries Related to Neuromarketing, Banking, and Advertising

In order to analyze the relevance and structure of the research field, an analysis of search queries related to the banking sector, advertising, and neuromarketing was conducted using the Google Keyword Planner tool. Based on the obtained data, a keyword map was created to illustrate the interconnections between the main concepts and directions within the studied field.



Figure 1. Interconnection of Keywords Related to Neuromarketing, Banking, and Advertising

Source: Author's own elaboration based on Google Keyword Planner data and Gephi visualization

The nodes on the network map represent individual terms with search query frequencies ranging from 70 to 7,480,000 impressions. The connections between nodes reflect associative relationships between terms, and color coding is used to identify thematic clusters formed based on semantic similarity. The main clusters identified within the network structure include banking, neuromarketing, neuromarketing methods, marketing, advertising, and behavior.

The resulting visualization demonstrates a high level of interconnection between marketing, advertising, and behavioral aspects of consumer perception. As shown in the figure, the cluster associated with marketing and advertising is closely integrated with the consumer behavior cluster, reflecting the key role of advertising communications in shaping decision-making processes.

In turn, the cluster related to behavioral aspects is directly connected with the banking sector, indicating the practical significance of neuromarketing approaches in financial services. This confirms that modern banking communications are increasingly viewed not only as tools for information delivery, but also as instruments of emotional and cognitive influence on consumers.

A special role in the network structure is played by the research methods cluster, which includes tools such as EEG, eye-tracking, and implicit methods. This cluster acts as a connecting element between different research directions, providing the methodological basis for analyzing consumers' cognitive and emotional reactions. The presence of these terms on the map confirms the growing interest in studying unconscious mechanisms of consumer behavior.

Kahneman's Model: System 1 and System 2

One of the key theoretical foundations of modern neuromarketing research is the dual-process theory proposed by Daniel Kahneman. This model explains the mechanisms of information perception and decision-making and helps to understand how consumer reactions to advertising stimuli are formed. According to Kahneman, a significant part of everyday decisions is made through so-called "fast thinking," in which reactions are formed automatically and often without conscious analysis. To describe this mechanism, Kahneman identified two interacting systems of information processing — System 1 and System 2 (Dunbar, L.).

System 1 is characterized by high-speed information processing and operates primarily on an unconscious level. It relies on intuitive judgments, previous experience, emotional reactions, and associative connections. System 1 is responsible for automatic perception of stimuli, rapid decision-making, and the formation of first impressions. Its functioning enables individuals to react quickly to changes in the external environment, which is essential for everyday activity and adaptation.

However, the functioning of System 1 is associated with the use of cognitive shortcuts and heuristics, making it susceptible to cognitive biases and perceptual errors. System 1 operates automatically and requires little cognitive effort or subjective sense of control over the thinking process (Kahneman, D., 2011).

System 2, in contrast, functions slowly and sequentially, relying on rational analysis and conscious control. It becomes active in situations that require logical reasoning, comparison of alternatives, planning, self-control, and deliberate decision-making. The operation of System 2 involves high cognitive effort; therefore, individuals tend to engage it mainly in situations that demand focused attention and analytical information processing.

System 2 supports directed attention and complex cognitive processes, including critical thinking, argument analysis, and conscious decision-making. Its functioning is typically accompanied by a sense of concentration, awareness, and control over one's actions (Kahneman, D., 2011; Drăgoi, D.A., 2024).

Thus, Kahneman's model demonstrates that thinking is not a single unified process but rather the interaction of automatic and reflective mechanisms. The dominance of System 1 allows individuals to respond quickly in routine situations, whereas System 2 provides deeper analysis and conscious choice (Dunbar, L.).

The dual-system theory is particularly important for neuromarketing because a large proportion of consumer decisions are made intuitively and automatically. Neuromarketing research is largely focused on studying System 1 reactions, as this system determines the initial perception of advertising stimuli, the formation of emotional associations, and automatic preferences (Genco, 2013).

This is especially relevant in the context of advertising communications, since primary automatic reactions largely determine subsequent cognitive information processing and the consumer's final attitude toward a product or brand. Understanding the mechanisms of System 1 enables marketers to design advertising messages that more effectively capture attention, evoke emotional responses, and create stable associative connections.

Rational and Emotional Advertising

Advertising can be considered a multi-level communication process that includes input stimuli, internal cognitive and emotional processes, as well as behavioral outcomes (Tellis, G.J., 2004).

The effectiveness of advertising communication largely depends on how deeply the advertising message influences the processes of perception, attention, and emotional evaluation of the consumer (Astolfi et al., 2009).

At the same time, it is becoming increasingly evident that the key factor of advertising effectiveness is not the advertising stimulus itself, but rather the way it is perceived by the consumer's brain (Ambler, Ioannides & Rose, 2000). In this context, the study of the mechanisms involved in processing, assimilation, and storage of advertising information becomes critically important for

understanding the real impact of communication (Plassmann, H., Ambler, T., Braeutigam, S. and Kenning, P., 2007).

In the academic literature, two main types of advertising appeals are traditionally distinguished: rational and emotional.

Rational advertising focuses on communicating information about the functional characteristics, benefits, and advantages of a product. It aims to reduce uncertainty and support reasoned decision-making, which is particularly important in the field of financial services (Albers-Miller & Stafford, 1999).

Emotional advertising, in contrast, is aimed at generating affective reactions and associations such as trust, confidence, joy, and security (Keshari & Jain, 2014).

In the context of companies striving to improve the effectiveness of marketing investments, pre-testing of advertising materials becomes especially important, as it allows the evaluation of advertising potential before market launch (Astolfi et al., 2009).

It is within this context that neuromarketing opens fundamentally new research opportunities by enabling the identification of subconscious audience reactions and allowing researchers to more accurately determine which elements of advertising messages truly influence consumer behavior (Ariely & Berns, 2010; Morin, 2011).

Implicit Association Test (IAT)

The Implicit Association Test (IAT), developed by Greenwald and colleagues, is one of the most widely used methods for measuring unconscious attitudes and associative connections.

This method is based on measuring reaction time during stimulus classification tasks. It is assumed that individuals respond more quickly to stimuli that are already linked through stable associative connections. Differences in reaction time between congruent and incongruent categories make it possible to determine the strength of these associations (Greenwald et al., 2003).

Unlike traditional survey methods, the IAT enables the measurement of hidden attitudes and is less affected by social desirability bias and conscious control from respondents. This makes the method a more effective tool for analyzing unconscious aspects of consumer behavior and increases the accuracy of behavioral prediction (Brunel et al., 2004; Maison et al., 2004; Friese et al., 2006).

In the context of advertising research, the IAT is used to evaluate the strength of associations between advertising stimuli and specific characteristics, including emotional and rational attributes. The use of this method allows for a deeper analysis of advertising perception and helps identify hidden mechanisms underlying the formation of attitudes toward a product or brand.

Research

In order to demonstrate the applicability of the Implicit Association Test (IAT), a study based on the measurement of implicit associations was conducted.

The study involved 24 respondents who actively used banking cards in their everyday lives. The participants' age ranged from 25 to 45 years, which made it possible to target the audience most actively engaged in the use of banking products.

The aim of the study was to evaluate the perception of different types of advertising stimuli, namely rational and emotional images related to banking card usage.

Research Hypotheses

H1. The type of advertising image (emotional vs. rational) influences the formation of implicit associations with a banking card.

H1a. Emotional advertising images create stronger implicit associations with emotional characteristics (calmness, confidence, freedom) than rational images.

H1b. Rational advertising images create stronger implicit associations with functional characteristics (control, benefit, convenience) than emotional images.

H1c. Respondents' reaction time in associating a banking card with relevant characteristics is lower (faster) when the type of image corresponds to the type of characteristics: for emotional creatives — emotional characteristics; for rational creatives — functional characteristics.

H1d. In creatives with neutral visuals, the differences between emotional and rational associations are less pronounced.

H0. The type of advertising image does not have a statistically significant influence on the formation of implicit associations with a banking card.

Research Procedure

The study was conducted using the iCode platform, designed for neuromarketing and implicit research based on the analysis of reaction time and automatic associative connections of consumers. During the experiment, respondents were sequentially shown visual materials containing an integrated image of a banking card. To ensure the consistency of the experiment, the banking card was positioned in the same area across all creatives.

In total, respondents were shown six images: two emotional, two rational, and two neutral.

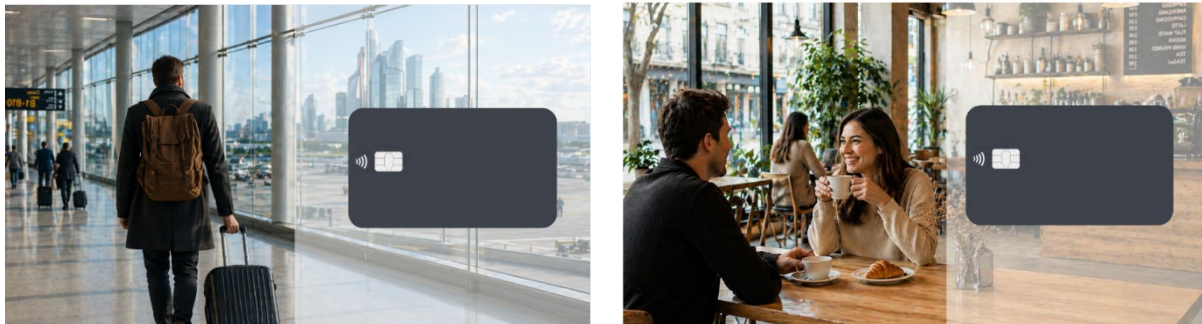


Figure 2. Examples of Emotional Advertising Stimuli

Source: Author's own elaboration



Figure 3. Examples of Rational Advertising Stimuli

Source: Author's own elaboration

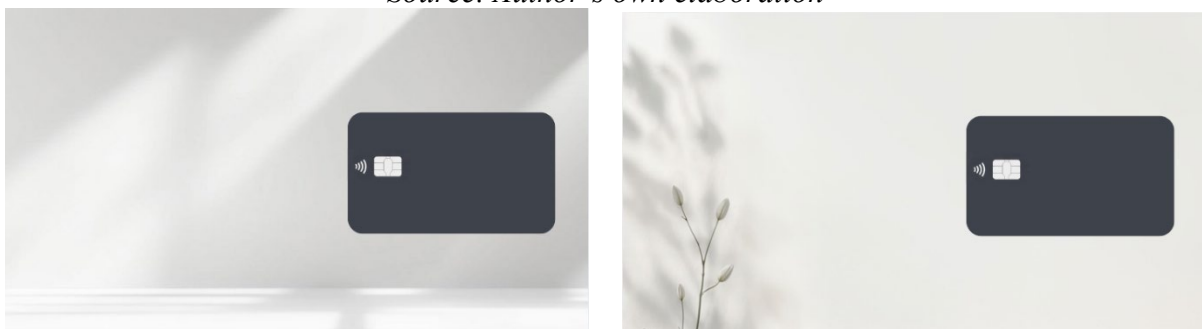


Figure 4. Examples of Neutral Advertising Stimuli

Source: Author's own elaboration

After viewing each image, respondents were asked to select the associations evoked by the creative. For this purpose, two groups of associations were used: emotional and rational.

Emotional associations included categories reflecting affective perception and subjective feelings, such as trust, confidence, and freedom. These associations are linked to automatic reactions and are primarily formed at the level of System 1, which is responsible for fast and intuitive information processing.

Rational associations included characteristics reflecting functional aspects of perception, such as speed, simplicity, and control. These associations are connected with more conscious information processing and correspond to the functioning of System 2, which is oriented toward logical analysis and evaluation of product advantages.

The division of associations into emotional and rational categories made it possible to more accurately assess the nature of advertising perception and identify differences in respondents' unconscious reactions depending on the type of advertising stimulus.

Research Results

Hypothesis H1 is confirmed. The results demonstrate that the type of advertising image influences the formation of implicit associations. The obtained results showed that rational creatives generated stronger and more stable associations with functional characteristics such as speed, simplicity, and control. These associations were characterized not only by a high percentage of positive responses, but also by more confident and stable reactions.

At the same time, emotional creatives generated a significantly higher number of PTC responses. This indicates that emotional advertising stimuli activated more complex internal cognitive and emotional processing. Thus, emotional associations were expressed not only through direct positive responses, but also through hesitation reactions reflecting deeper automatic emotional perception.

Therefore, the type of advertising image significantly influenced both the structure and the nature of implicit associations.

Hypothesis H1a is confirmed. Emotional advertising images created implicit associations with emotional characteristics such as trust, confidence, and freedom. Although these associations were not always expressed through the highest levels of firm positive responses, the PTC analysis demonstrated elevated levels of hesitation for emotional congruent pairs.

Hypothesis H1b is confirmed. Rational creatives demonstrated the highest levels of associative connection with functional characteristics and produced the strongest results within the entire study.

Hypothesis H1c was partially confirmed. It was assumed that respondents would react faster when the type of advertising image corresponded to the type of characteristics.

The results demonstrated that congruent rational pairs produced the fastest and most confident reactions. Rational creatives associated with functional characteristics generated lower hesitation levels and more stable implicit connections.

At the same time, congruent emotional pairs generated higher PTC levels and more hesitation responses. However, this should not be interpreted as the absence of emotional associations. On the contrary, elevated hesitation indicates more complex automatic emotional processing and higher emotional involvement.

Hypothesis H1d was partially confirmed. Neutral visuals demonstrated lower intensity of emotional associations compared to emotional and rational creatives. However, even within neutral contexts, respondents still demonstrated relatively high associative connections with functional characteristics. In addition, the PTC analysis showed that neutral stimuli also generated hesitation responses, especially regarding simplicity and control. This suggests that banking cards themselves already possess stable implicit functional associations independent of strong advertising context.

Therefore, neutral visuals reduced the intensity of emotional processing but did not completely eliminate associative differences between emotional and rational characteristics.

7.6 The null hypothesis H0 is rejected. The results revealed significant differences both between the types of advertising images and between different visual contexts.

Table 1. Indicators obtained during the research

BRAND	STATEMENT	n=24				
		DECLARATIONS		CONFIDENCE LEVELS		DECLARATIONS
		YES	FIRM YES	HESITANT YES	HESITANT NO	FIRM NO
neutral_flower	Confidence	38	29	8	17	46
	Freedom	46	17	29	21	33
	Trust	46	13	33	29	25
	Speed	75	50	25	21	4
	Simplicity	88	50	38	8	4
	Control	58	25	33	25	17
rational_process_card	Confidence	57	39	17	17	26
	Freedom	52	35	17	22	26
	Trust	58	17	42	17	25
	Speed	92	58	33	4	4
	Simplicity	79	29	50	17	4
	Control	67	33	33	21	13
emotional_lyfestyle_cafe	Confidence	54	46	8	17	29
	Freedom	54	25	29	17	29
	Trust	58	25	33	13	29
	Speed	70	35	35	22	9
	Simplicity	73	45	27	18	9
	Control	58	25	33	21	21
rational_process_phone2	Confidence	71	50	21	13	17
	Freedom	63	29	33	17	21
	Trust	63	25	38	25	13
	Speed	96	50	46	0	4
	Simplicity	96	46	50	0	4
	Control	75	46	29	17	8
neutral_wave	Confidence	46	33	13	21	33
	Freedom	48	30	17	35	17
	Trust	43	22	22	35	22
	Speed	70	35	35	17	13
	Simplicity	83	30	52	9	9
	Control	52	24	29	29	19
emotional_lyfestyle_airport	Confidence	70	52	17	17	13
	Freedom	75	33	42	13	13
	Trust	55	27	27	32	14
	Speed	83	52	30	13	4
	Simplicity	75	42	33	21	4
	Control	67	21	46	21	13

Source: www.icode-platform.com

Key Findings

The results of the study demonstrate that rational advertising creates stronger and more distinct implicit associations, particularly in relation to functional characteristics such as speed, simplicity, and control. Emotional advertising, in turn, forms more diffuse associations related to subjective states, including trust, freedom, and confidence. At the same time, visual context significantly influences both the perception of advertising images and the formation of associative connections. The findings also support Daniel Kahneman’s dual-system theory of thinking. Rational advertising images are more strongly associated with the activation of System 2, which is responsible for logical analysis, structured information processing, and conscious decision-making, whereas emotional stimuli primarily activate System 1, which is linked to fast, automatic, and associative reactions. In this regard, System 2 demonstrates more stable and predictable responses, while System 1 reactions are characterized by greater variability and dependence on contextual factors.

Conclusions

This study examined the possibility of applying the Implicit Association Test (IAT) to evaluate the effectiveness of advertising images in the banking sector. The obtained results confirm that implicit methods make it possible to identify hidden mechanisms of advertising perception that remain inaccessible through traditional survey-based approaches.

The research demonstrated that the type of advertising image significantly influences the formation of associative connections among consumers. Rational advertising stimuli generated stronger and more stable associations with functional characteristics such as speed, simplicity, and control. This indicates that rational images effectively shape the perception of utilitarian benefits of banking products, which is particularly important in the context of financial decision-making.

Emotional advertising images, in turn, generated associations related to subjective states such as trust, confidence, and freedom. However, these associations appeared less pronounced and more variable, indicating their dependence on context and individual perception. Within the neuromarketing framework, this confirms that emotional stimuli activate more complex and less predictable cognitive processes.

Particular importance within the study was attributed to the visual context of advertising images. It was found that creatives demonstrating the process of using a banking card formed the strongest associations with functional characteristics. At the same time, lifestyle visuals mainly influenced emotional perception, although their effectiveness varied depending on the specific scenario. Neutral images demonstrated the weakest associative connections, confirming their role as a baseline level for comparison.

The results of the study are consistent with Daniel Kahneman's dual-system theory of thinking. Rational advertising stimuli are more closely associated with System 2, which provides structured and conscious information processing, while emotional stimuli activate System 1, which is related to fast and automatic reactions. Neuromarketing methods, in turn, make it possible to capture System 1 reactions, which makes them particularly valuable in the analysis of advertising communications in the banking sector.

Thus, the use of the Implicit Association Test within a neuromarketing framework allows for a deeper analysis of consumer behavior and helps identify differences between declared and actual consumer reactions. The practical significance of the study lies in the possibility of applying implicit methods for pre-testing advertising creatives, improving communication effectiveness, and developing more accurate promotion strategies for banking products.

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STRATEGIC APPROACH TO THE ECONOMIC RECONFIGURATION OF RIVER TOURISM IN THE REPUBLIC OF MOLDOVA

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Abstract: *This paper examines the potential of river tourism in the Republic of Moldova in the context of the sustainable valorization of its hydrographic network. Although the national river system totals approximately 16,000 km, its economic use remains limited, being concentrated mainly on major rivers, while smaller watercourses are insufficiently integrated into the tourism circuit.*

The findings highlight the evolution of river tourism from traditional navigation-based forms to integrated approaches that combine water-based and riverside activities, in line with sustainable development principles. The European examples analyzed demonstrate the role of river tourism in stimulating rural economies, preserving cultural heritage, and supporting environmental conservation.

The case study of the Republic of Moldova reveals an early stage of development, characterized by insufficient infrastructure, institutional fragmentation, and a limited tourism offer. However, significant opportunities are identified, including access to European funding and the growing demand for alternative tourism.

The paper concludes that river tourism can become a viable tool for territorial development, provided that an integrated strategy is implemented, infrastructure investments are made, and cross-border cooperation is strengthened.

Key words: *river tourism, inland waterway network.*

JEL: L83, L89, M29, O10, O52

Introduction

The hydrographic network of the Republic of Moldova is made up of 3,621 rivers and streams, 8 of which are over 100 km in length—such as the Nistru, Prut, Răut, Bâc, Botna, Ichel, Cogâlnic, and Ialpuș—and 247 are over 10 km long. The total length of rivers across the territory of the Republic of Moldova is approximately 16,000 km. Moldova's hydrographic network is part of the Black Sea basin, due to the general slope of the terrain from northwest to southeast.

Analyzing data from the National Bureau of Statistics and the "Apele Moldovei" Agency, we have synthesized the following functions of the Moldovan river network:

- Maintaining biodiversity;
- Supplying drinking water;
- Irrigating agricultural land;
- Sources of industrial and domestic water;
- Disposal of wastewater;
- Waterway transport routes.

Most of the above-mentioned functions are carried out by the main arteries—the Nistru and the Prut, which are navigable over a stretch of 410 km, according to NBS data (2026).

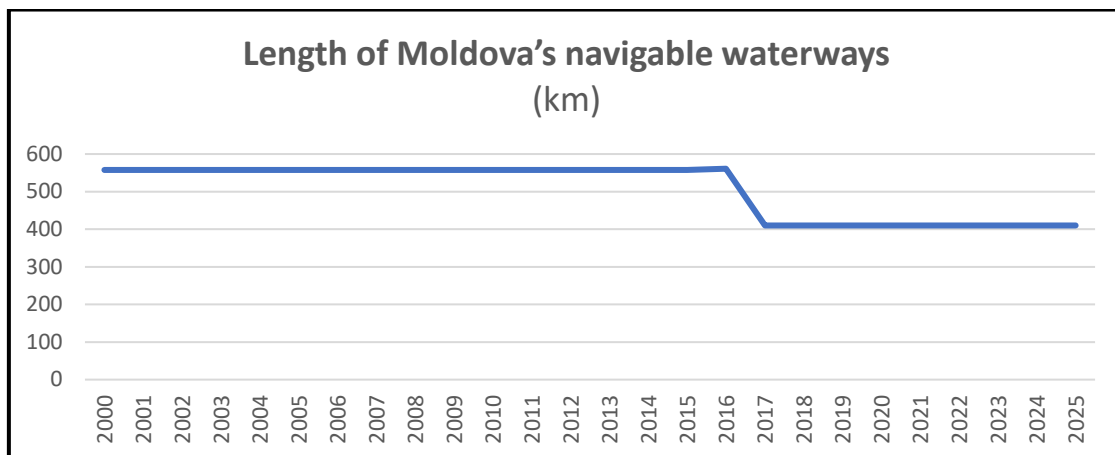


Figure 1. Length of Moldova's navigable waterways, 2000 - 2025

Source: Created by the author based on data from the National Bureau of Statistics <https://statistica.gov.md/ro/banca-de-date-statistice-78.html>

The smaller rivers—accounting for approximately 15,500 km of watercourses—serve primarily to shape and sustain the biodiversity of the territory and are excluded from the country's economic circuit, as their geographical characteristics do not support their traditional use, leaving them abandoned. An alternative way of utilizing Moldova's rivers is imperative.

From Traditional Waterway Use to Modern River Tourism: European Trends and Transformations

In the 1960s–1970s, Europe experienced a trend of specialization in tourism offerings, both due to the emergence of new motivations in demand and the exhaustion of traditional tourism models (Woessner, 2006).

The new social structure, the consequences of mass tourism, and environmental awareness favored the European trend of specialization in tourism offerings, turning it into a social and market reality in the 1980s. The ecological movement of this period, which spread throughout society as a lifestyle, and the crisis of mass tourism, caused by the oversaturation of traditional destinations, highlighted the need for new forms of tourism that would not threaten the environment. Thus, in the 1990s, with the infiltration of sustainable development principles into tourism and the emergence of the concept of sustainable tourism, the trend of developing alternative tourism was established.

Alternative tourism is a concept introduced by sustainable tourism theory to describe new forms of tourism intended to offer an escape from modernity, seeking authenticity, unspoiled natural environments, and living in contact with local cultures in underdeveloped areas.

Existing literature indicates that alternative tourism offers tourists a unique, differentiated experience and reflects the increase in "experiential learning" vacations. In other words, alternative tourism refers to tourists—usually in small groups—who travel to learn about and experience the characteristics of a specific area. Alternative tourism represents forms of tourism that oppose conventional tourism, opting for marginalized destinations.

According to Woessner (2006), the early period of river tourism is the 19th century, with the development of river transport in Europe and the organization of cruises on the Danube and Rhine rivers by river entrepreneurs, gaining momentum in the 1970s and 1980s with nautical river activities—river excursions and river cruises. The renewal came from the United Kingdom. Its aging and inconvenient river network would have disappeared in the 20th century if a specific culture had not taken hold on its waterways. After World War I, the magazine *The Yacht* followed river cruise chronicles, and in 1927, the work *The River Yachting* confirmed the British tendency for river tourism.

Tourist and sports activities have allowed the maintenance of watercourses in satisfactory condition, even reclaiming abandoned sections. British river activities are structured and coordinated in England and Wales by the Canal & River Trust (www.canalrivertrust.org.uk) and in Scotland by Scottish Canals (www.scottishcanals.co.uk), together with specialized associations and the private sector, which quickly turned toward the United States, a major source of tourists, and France, with its well-maintained river networks suitable for small vessel navigation. The British invested in the French Freycinet networks and the Canal du Midi, building new and renovating old boats, then expanded, focusing particularly on historical waterways.

Irish authorities adopted the British model of river tourism development and created Waterways Ireland in 1994, reopening the Shannon-Erne system. Today, the United Kingdom and Ireland are reference countries in the development of river tourism (Cooper & Pridaux, 2009).

River tourism in the 1980s–1990s is characterized by interest in nautical activities (river cruises, river yachting, river excursions) and the development of river areas to support these activities (Cooper & Pridaux, 2009).

After 2000, there was a shift in the philosophy of river tourism development, with the scene reversing. The issue of river tourism no longer resides in adapting the river for tourism activities but in adapting tourism practices to the river. Classic river tourism, based on the watercourse, evolves into modern river tourism that values both the watercourses and the riverbanks (Cooper & Pridaux, 2009).

VNF, an organization established in 2001 with a significant contribution to monitoring and studying river tourism in France and Europe, states that this form of tourism encompasses a wide range of activities on waterways, canals (river cruises, boat tours, proximity yachting, etc.), and their banks (recreational fishing, hiking, cycling, etc.) within a 20 km radius.

Tabel 1. The main forms of river tourism

Place where the tourist activity takes place	Tourist activity		
Tourist activities practiced along the watercourse	Recreational river navigation	River cruises	River angling
		River barge cruises	
		River excursions	
		Rover Yahting	
	Proximity water sports	Kayaking-canoeing	
		Rowing	
		Water Skiing	
		Other water activities (banana boat, catamaran, etc.)	
		Rafting	
Tourism activities practiced along the riverbanks	Hiking Trekking Cycling Riverside equestrianism Visiting riverside tourist attractions, etc.		

Source: created by the author

After 2009, the importance of river tourism became widely acknowledged, with more quantitative studies on the subject, such as reports from the tour operator TUI, the Danube Management Commission, etc. However, river tourism is often perceived as primarily river cruises. In an attempt to define it, Pierre Peyret states that modern river tourism is not limited to river navigation, but fits into a broader range of activities across an area that exceeds the linearity of the watercourse (Peyret, 2006).

Thus, by expanding its scope of activity, river tourism can be considered a solution for all types of watercourses, regardless of their hydro-morphological characteristics and the level of development of navigation infrastructure, and it can enhance the value of riparian areas.

River Tourism Best Practice

European countries offer several exemplary models of river tourism development. In France, the Canal du Midi has become a UNESCO World Heritage Site and a hub for cultural and recreational tourism. Local authorities, in collaboration with VNF, have developed cycling trails, restored historical locks, and promoted houseboat tourism.

In Germany, the Elbe River corridor integrates natural and cultural tourism, combining canoeing with visits to historic towns like Dresden and Meissen. Public-private partnerships ensure the maintenance of infrastructure and environmental conservation.

In the Netherlands, river tourism is integrated with broader water management strategies, including flood prevention systems that double as recreation zones. Dutch river tourism emphasizes eco-tourism principles and includes electric boats and floating lodges.

Ireland's Shannon-Erne Waterway, restored in the 1990s, exemplifies transnational cooperation between the Republic of Ireland and Northern Ireland. Managed by Waterways Ireland, the waterway supports boating, angling, and festivals, revitalizing rural economies.

These international examples demonstrate the potential of river tourism not only as a recreational activity but also as a sustainable development strategy. Moldova can adapt elements of these practices, such as infrastructure reuse, stakeholder engagement, and tourism-environment synergies. In addition to Western models, it is also relevant to analyze best practices from Central and Eastern European countries, such as Romania, Serbia, and Ukraine, which also possess hydrographic networks in need of economic revitalization through tourism:

- *Romania* – Through the “2030 Integrated Sustainable Development Strategy of the Danube Delta,” Romania has prioritized the development of slow and ecological tourism in the Danube Delta region, focusing on birdwatching, ecotourism, and slow cruises. Studies show a significant increase in local income and a higher degree of biodiversity conservation (Panagoret, D.M., et al., 2020).

- *Serbia* – Ecotourism corridors have been developed along the Sava and Tisza rivers, utilizing EU funds via IPA Cross-Border Programmes, with local communities involved in the development of guesthouses and thematic tours.

These examples highlight the importance of cross-border cooperation and the integration of river tourism into regional sustainable development strategies.

The expansion of river tourism in the European Union, particularly in Western Europe, has compelled regional decision-makers to develop integration and development projects that take into account the physical continuity of waterways, transcending administrative borders and involving neighboring riparian regions. As such, river tourism, through its transversal nature, stimulates cross-border cooperation.

The economic impact of river tourism is relatively modest at the national level. Its value lies in its capacity to stimulate local economies that lack alternative development options due to spatial and mental discontinuities created by river corridors. It generates increased income and commerce in rural areas, creates business opportunities, and boosts other sectors such as construction and transport. Public investments in river tourism tend to yield a high medium-term return and are often sourced from domestic funds. Leakages in river tourism are low.

River tourism has positive cultural, social, and environmental effects. It contributes to raising the standard of living, improving local infrastructure, public health, and safety, revitalizing cultural and religious traditions, enriching the tourism heritage with new cultural facilities, regenerating abandoned watercourses, restoring riverbanks, preserving habitats for plants and animals, and maintaining the scenic and aquatic quality of the river network.

In his 2006 article "*L'émergence du tourisme fluvial en Europe*", Raymond Woessner identifies the British model of river tourism development as having had the greatest influence on the emergence of this form of tourism, and he outlines the following key aspects:

- The pre-existing canal culture, reinforced through artistic representations. The works of painter John Constable contributed to the early aestheticization of British waterways and their multiple uses, culminating in the writings of Thomas Caswall Rolt in the 1960s, which marked a turning point;
- A fundamental shift in the use of narrowboats: the economic function of transporting goods was replaced by a touristic function;
- The conservation of the industrial heritage associated with canals;
- The emergence of a recreational conception of waterways, particularly through sport.

Benoît Pin synthesizes these ideas and those of other scholars by describing the process of European river tourism development through the following sequence:

Aestheticization → Heritage-making → Institutionalization → Touristic development (Pin, 2004, p.145). This formula emphasizes the need for strong political intentionality in order to enable the successful evolution of river tourism. River tourism mainly utilizes natural and artificial river networks originally built for other purposes. In some cases, promoting river tourism involves restoring locks, bridges, tunnels, towpaths, and other related infrastructure.

Table 2. Infrastructure and Equipment Required for River Tourism

Activities	Tourist Infrastructure and Technical Base	Equipment
Recreational navigation	Navigable waterways and leisure river networks	Cruise ships, yachts, rafting equipment
Proximity nautical Tourism	Marinas, rafting routes, signage, rafting clubs	Canoeing, kayaking, rafting gear, catamarans, water skis, etc.
Cycling	Cycle itineraries, campsites and rest areas, signage	Bicycles and cyclist gear
Hiking and Trekking	Towpaths, campsites and rest areas, signage	Walking gear (tracksuits, boots, backpacks, etc.)
Recreational Fishing	Signage, small boats	Fishing tools and equipment

Source: Created by the author

River Tourism in Moldova – An Alternative Approach to Reviving Abandoned Waterways

In the Republic of Moldova, river tourism remains an occasional and underdeveloped form of tourism. Although the country possesses significant fluvial potential, it is insufficiently capitalized. Current activities manifest in two main categories: water-based tourism (such as river cruises and short-distance navigation) and riverside recreational tourism (including walks, picnics, leisure stays, fishing, swimming, and sunbathing).

An analysis of Moldova's official tourism information platforms (<https://turism.gov.md> and <https://moldova.travel>), as well as field observations conducted in locations such as Vadul lui Vodă, Orheiul Vechi, Zăluceni, Vărnăcău, Țirgul Vertiujeni, and Florești, revealed the following river-based tourism products:

- **River cruises on the Nistru River** aboard the vessel *Legenda*, which has a capacity of 300 passengers and offers overnight stays in two cabins equipped with convertible sofas. The boat is also available for private events.
- **One-day river excursions** on the Nistru (Rezina – Saharna – Țipova), lasting 4 to 6 hours, include visits to major tourist attractions: in Țipova, the "Assumption of Mary" Monastery and the

rupestrian monastery of the same name; in Saharna, the "Footprint of the Virgin Mary," the Holy Trinity Monastery, Saharna Cemetery, the Saharna Waterfalls, the "Annunciation" rupestrian monastery, and the sacred spring – all visited aboard the *Moscova* ship.

- **Canoeing and kayaking trips** lasting 2–7 hours, on stretches of 10–22 km along the Nistru near Chişinău.
- **Proximity navigation**, including leisure boat rides and catamaran excursions.
- **Riverside events** such as the "Nistru Fest" held in Zăluceni (Floreşti District) and "Beleu Bio Fest" in Slobozia Mare (Cahul District).
- **Walking tours** along riverbanks and floodplain areas.
- **Visits to riverside cultural and natural attractions.**
- **Picnicking and swimming** in natural settings.

Table 3. SWOT Analysis

Strengths	Weaknesses
– Unspoiled natural environment – Rich tourism potential – Favorable geographical location – The fluvial identity of the country's capital – Lack of natural resources for traditional tourism development	– Lack of transport and tourism infrastructure – Poorly developed accommodation infrastructure – Absence of public initiatives in river tourism – Limited awareness of river tourism concept – Poor ecological condition of water bodies
Opportunities	Threats
– Access to European funding (Interreg, ENI CBC, IPA, etc.) – Integration into European tourism networks (e.g., Danube, Nistru, Prut) – Growing global interest in ecological, slow, and adventure tourism – Reuse of old infrastructure (bridges, towpaths) for tourism activities – Strategic positioning between Romania, Ukraine, and the EU markets	– Low tourist flows – High seasonality – tourism limited to warmer months – Low incomes of the local population – Political instability and lack of administrative continuity – Frequent floods or droughts affecting navigability – Weak connectivity between river zones and major urban centers

Source: Created by the author

River tourism in the Republic of Moldova is in its early stages of development, characterized by a lack of organization and poorly developed infrastructure. Nevertheless, Moldova's status as a Danubian country offers a unique opportunity for integration into the broader European tourism circuit of the Danube hydrographic basin. Cooperation with the European Union opens up access to funding opportunities and cross-border partnerships, which are essential for the sustainable development of river tourism in Moldova.

Strategic Outlook on the Development of River Tourism in the Republic of Moldova

The lack of access to the sea and the impossibility of developing coastal tourism presents an opportunity for the advancement of river tourism in the Republic of Moldova. Due to its dense hydrographic network, Moldova has the potential to develop most river tourism activities, with the exception of rafting, which requires a mountainous or hilly terrain.

To ensure the competitive development of river tourism in Moldova, investments in both river and general tourism infrastructure are essential. Furthermore, since the country's main navigable arteries constitute state borders, the tourism valorization of Moldova's hydrographic network requires cooperation with neighboring countries that share the same watercourses of touristic interest.

The historical analysis presented shows that river tourism in the European Union has developed through intentional actions—either public or private. Therefore, the development of river tourism in the Republic of Moldova can only be achieved through a concerted and sustained effort.

Feasibility studies and the elaboration of a tourism development master plan for the river network are necessary. Given that river networks and their banks represent vast territories with dispersed resources and complex infrastructural needs, a uniform tourism development approach is required. However, due to the scope and thematic limits of this paper, as well as the author's available resources and specialization, a full-fledged plan cannot be proposed here. Instead, we suggest a medium-term territorial development framework based on four priority axes:

1. Encouraging riverside activities – hiking, trekking, etc., by identifying the most attractive trails and locations, especially for domestic tourists, and equipping them with the necessary infrastructure (tourist signage, maintenance of towpaths which often accompany rivers);
2. Development and promotion of recreational fishing;
3. Organizing artistic events in rural riverside communities to promote river destinations;
4. Enhancing the attractiveness of the Giurgiulești port as a docking point for river cruise ships.

The directions outlined above are indicative and schematic. A much broader study is needed for their proper implementation. However, they offer a roadmap for initiating activities with low costs and minimal effort.

Conclusions

River tourism development varies across Europe. France, Germany, the UK, Ireland, and the Netherlands have integrated their river systems into multifunctional development models. Moldova, though currently underdeveloped in this regard, possesses similar structural characteristics.

River tourism represents a viable strategy for reactivating Moldova's neglected hydrographic network. Policymakers should prioritize the creation of a National River Tourism Strategy aligned with EU frameworks. Investment in basic river infrastructure, awareness campaigns, and transborder projects would enhance regional cohesion and economic diversification. The paper advocates a theoretical repositioning of rivers—from utilitarian channels to vectors of territorial resilience.

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THE IMPACT OF INVESTMENTS IN INCLUSIVE EDUCATION ON LONG-TERM ECONOMIC GROWTH

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Abstract: *This paper analyzes the fundamental relationship between investments in inclusive education (IE) and long-term economic development, with a particular focus on the context of the Republic of Moldova. Grounded in human capital theory, the research demonstrates that inclusive education is not merely a moral obligation, but a strategic investment that maximizes individual potential and labor productivity. At a global level, international models (Scandinavian, North American, Dual) provide benchmarks for best practices, highlighting that the early integration of vulnerable groups significantly reduces future social costs. The analysis underscores a "circular interdependence": inclusive education enhances the quality of the workforce, stimulates innovation through diversity, and transforms social assistance beneficiaries into active taxpayers. In the Republic of Moldova, progress is visible through the consolidation of the legislative framework (2022-2027 Program) and the expansion of Resource Centers (CREI). Data indicates a positive correlation between specific funding and the increased school retention of children with special educational needs (SEN). However, the sustainability of the system is threatened by structural barriers: unadapted infrastructure, a shortage of specialists, and social stereotypes. The conclusions emphasize that the Republic of Moldova is at a turning point. To ensure sustainable economic growth, it is imperative to shift from mere classroom presence toward efficient resource management and digitalization. Ultimately, inclusive education is presented as the essential catalyst that can transform society from a system based on assistance into one grounded in empowerment and economic efficiency.*

Key words: *inclusive education, human capital, sustainable economic growth, strategic investment, school retention.*

JEL: I25, J24, O15

Introduction

In contemporary specialized literature, the relationship between investment in education and economic growth forms the core of human capital and endogenous development theories, which highlight the essential role of knowledge and skill development in the growth of modern economies. As a fundamental pillar of human capital formation, education takes on strategic importance, and its inclusive dimension is becoming increasingly relevant in today's societies.

Foreign direct investments are essential sources and primary factors driving a country's economic development. While the impact of these investments depends on economic, political, and social factors—and despite the common perception that foreign investment has a positive impact—there is still a lack of understanding regarding the orientation of investments within the inclusive education system.

In this context, investing in inclusive education represents not only a social and moral necessity but also an economic opportunity. Ensuring equitable access to education contributes to skill development, increased labor productivity, and the reduction of social inequalities—all of which are essential factors for a competitive and sustainable economy. Thus, inclusive education becomes a mechanism through which societies can harness the full extent of available human potential.

The relevance of this topic is particularly pronounced in the context of the Republic of Moldova, where challenges related to social inclusion, access to quality education, and the efficiency of public investment remain pressing. Analyzing the impact of inclusive education investments on economic

growth offers a complex perspective on how educational policies can influence long-term economic development. This research aims to contribute to the development of the conceptual and practical framework regarding the role of inclusive education in the modern economy, focusing on effective public policies and sustainability. In an era of globalization, the economic sustainability of the Republic of Moldova depends on the capitalization of underutilized human capital. The topic is of critical importance because:

- It aligns with the **Inclusive Education Development Program 2022-2027**.
- It addresses the "**circular interdependence**" between education, labor productivity, and the state's financial health.
- It analyzes the necessary transition from a social assistance model (resource consumer) to one of **economic empowerment** (resource generator).

The aim of this paper is to highlight the relationship between investment in inclusive education and sustainable economic growth by analyzing the mechanisms through which education contributes to human capital formation and the reduction of economic disparities. Additionally, the paper aims to identify best practices, analyze the current situation, and formulate recommendations for improving public policies in this field.

The choice of the topic is supported by the need to quantify the effectiveness of investments in the education of children with Special Educational Needs (SEN) and vulnerable groups. The primary motivation is to demonstrate that the "**cost of exclusion**" is much higher in the long run than the initial investment in inclusion. The study is driven by the desire to provide solutions for structural barriers in Moldova (unadapted infrastructure, shortage of specialists) through the lens of successful international models (Scandinavian, Dual, North American).

Proposed Objectives:

- To analyze the impact of investments in inclusive education on the formation of a resilient and diversified human capital.
- To evaluate international best practice methods and their applicability within the inclusive system of the Republic of Moldova.
- To identify the direct correlation between per-student funding and the increase in school retention rates.
- To analyze the barriers in the management of human and financial inclusive services that limit the return on public investments.

The research methodology is based on the analysis of specialized literature, comparative studies, and the interpretation of relevant statistical data, providing an interdisciplinary approach to the investigated topic. Current research is grounded in fundamental theories—both classical (Adam Smith) and modern economic theories (James Heckman)—which demonstrate the high return on human capital investments. International models show that early integration reduces unemployment and the pressure on social assistance budgets. At the national level, the Republic of Moldova has moved beyond the experimental stage and is gradually aligning with EU standards through the creation of Resource Centers (CREI) and Psycho-pedagogical Assistance Services (SAP); however, despite legislative progress, practical implementation is hindered by social stereotypes and inefficient management of local resources.

Core Content

The concept of **Inclusive Education** is a continuous process of transformation within the educational system, as it responds to the needs of all students. According to UNESCO, inclusive education represents a process of eliminating learning barriers, ensuring the participation of young people regardless of their ethnic origin, language, abilities, or socio-economic status. Its fundamental principles are:

- Equity: providing reliable and differentiated support.
- Adaptability: tailoring the system to individual needs.

- Diversity: celebrating what makes each individual unique [16].

An inclusive economy is one that creates opportunities and benefits equitably. Therefore, we can consider that the pillars of an inclusive economy reduce income disparities and increase social cohesion, specifically by leveraging underutilized human capital.

The interdependence between inclusive education and economic development consists of two concepts linked in a circular causality. They act as a catalyst for long-term economic growth by:

- Increasing productivity.
- Reducing social costs: a higher employment rate among vulnerable groups alleviates pressure on social assistance budgets.
- Innovation through diverse economic environments: driven by the human capital formula, which can be represented through investment in education and healthcare.

The **interdependence between inclusive education and economic development** represents two concepts linked by circular causality. They act as a catalyst for long-term economic growth by increasing productivity and reducing social costs; a higher participation rate among vulnerable groups alleviates the pressure on social assistance budgets. Furthermore, it fosters innovation through diverse economic environments via the human capital formula, which can be represented as the result of investment in education and healthcare.

$$V_{CU} = \int_0^T e^{-rt} \cdot f(E_i, S_i) dt \quad (1)$$

E_i represents the level of inclusive education, and S_i represents the state of health.

The role of education in a country's economic development is critically important and unanimously accepted. We can affirm that education plays a dual role: on one hand, by providing the labor force required by the economy, and on the other hand, through research results that contribute to the development and implementation of new technologies. The link between education and economic growth has been a central concern for great economists since Adam Smith, who studied the relationship between investment in education and the wealth of nations. Today, we can state that there is a solid theoretical framework regarding the connection between the educational system and a country's economic growth. [17]

An international model for the development of inclusive education is Romania. The situation there has improved over the last 30 years with the support of UNICEF. In partnership with central, county, and local authorities, as well as NGOs, UNICEF Romania has developed and implemented a solution that utilizes existing local resources as efficiently as possible and creates stronger links between families, schools, and communities. [16]

The legal framework of the **Republic of Moldova** complies with international standards. The concept regarding the development of inclusive education, approved and reflected in policy documents, serves as a general framework for the inclusion of all children at high risk of exclusion; it is based on the principle of "education for all," aiming to capitalize on the learning potential of every child. Thus, the principle of inclusive education is not a separate entity; rather, inclusion constitutes an approach for the entire educational system. [10]

The objective of the **Quality Inclusive Education Package** is for all children to start school at the appropriate age, to learn to their full potential, and to be prepared for life. To this end, a school-family-community partnership has been created to support children.

Inclusive education is not limited to the integration of children with disabilities; it also aims to eliminate barriers to participation for everyone at risk of exclusion. According to the UNESCO

definition, it is a process of addressing and responding to the diversity of needs of all learners by increasing participation in learning, cultures, and communities. [15]

Economic inclusion is a system that creates opportunities for the population and distributes them equitably. The key pillars on which economic inclusion is based are: the removal of barriers for marginalized groups, the development of lifelong skills, and the involvement of citizens in economic decision-making. While classic economic growth is measured by **GDP**, economic inclusion emphasizes improving the quality of life for those at the "base of the pyramid."

One interdependence between economic development and inclusive education is the quality of school inclusion and the financial health of the state. This involves reducing social costs by training individuals to become active taxpayers and increasing productivity. Another method for implementing inclusive economic growth in our country would be following international models that approach the issue through different strategies:

- The Scandinavian Model (Finland, Sweden)- total integration where the school is the only option, with massive resources allocated for support and multidisciplinary teams within the institutions.
- The North American Model (Canada, USA)- guarantees the right to inclusion in the "least restrictive environment."
- The Dual Model (Germany)- emphasizes the transition toward vocational training and apprenticeships, linking education directly to the labor market.
- The Transition Model (Eastern Europe)- the shift from large residential institutions (orphanages) to CREI (Resource Centers for Inclusive Education) within community institutions.

The analysis of theoretical foundations and international models highlights that inclusive education is not merely a moral desideratum, but a pillar of the modern economy. However, translating these principles into daily reality depends critically on the mechanisms through which society chooses to distribute its resources. Moving from a conceptual vision to social impact requires a rigorous examination of the pragmatic side: investment. It is necessary to analyze the financial structure and national strategies that allow for the transformation of theoretical paradigms into infrastructure, human resources, and sustainable support services.

In the Republic of Moldova, the strategic framework is aligned with European objectives, emphasizing total integration. The **Program for the Development of Inclusive Education (2022-2027)** is the primary document outlining action directions, establishing clear indicators for accessibility and service quality. [4]

Despite progress, the management of inclusive services in national practice faces issues that require deeper analysis:

- Financial Resource Management -funding mechanisms are often implemented inefficiently, creating a gap between real needs and curricular adaptation or necessary equipment.
- Human Resource Management- currently, there is a significant shortage of qualified and accessible teaching staff, leading to the burnout of existing personnel and a decline in quality.
- Infrastructure Management- most institutions lack adapted infrastructure (access ramps, specialized restrooms for persons with disabilities, classroom accessibility) and efficient investment management at the local level.

These management challenges emphasize the need to improve, adopt, and adapt both local and international best practices. International practices, particularly from European Union countries, offer valuable models for optimizing the management of inclusive education. As the Republic of Moldova aligns itself with EU standards, it is essential to understand the following aspects: **needs-based funding** dedicated to individual requirements; **professional development** through mandatory training and mentoring; and an **impact assessment system** using progress indicators and economic methods. Strategic management of these services is the key to transforming the socio-economic potential of inclusive education in our country.

The evolution of education, along with the concepts and principles regarding its continuous development, has had a winding history, with specific trends emerging in different periods. The last decades in the history of education have been strongly marked by the promotion of **Inclusive Education (IE)** as a vital foundation for ensuring equal opportunities for all children. The concept of IE emerged as a response to traditional, obsolete approaches where certain categories of children were excluded from mainstream schools due to disabilities, learning difficulties, family vulnerability, or other reasons, and placed in residential boarding-type institutions. Global research provides sufficient evidence of the harmful effects of institutionalization on child development. Thus, it is found that the most vulnerable category of children are those with disabilities, who are more prone to various forms of neglect, abuse, and violence. [15]

According to the works of **James Heckman**, economic inclusion yields long-term economic returns. Investing in inclusive education impacts long-term growth by maximizing each individual's potential and improving problem-solving capacities. Graduates of inclusive programs have higher employment rates and, consequently, higher tax contributions, having a positive effect on **human capital**. As they adapt their skills to societal needs, human capital becomes more resilient and diversified. Such success has been seen in countries like **Estonia and Canada**, where early integration has led to a drastic decrease in unemployment among persons with disabilities. [5]

Analyzing the situation in our country, we observe a significant evolution from the creation of Resource Centers to the current integration in schools; however, directed budgets have influenced the school retention of children with **Special Educational Needs (SEN)** over the last five years. The barriers facing child integration include parental resistance, building infrastructure, and a shortage of specialists.

Inclusive education is an economic catalyst. In Moldova, progress is visible, but sustainability depends on the continuity of investment. Although the national context faces social and structural barriers, we can confirm the necessity of a strategic vision regarding allocated resources. Thus, the transition from Resource Centers toward full integration in schools should not be viewed merely as a budgetary expense, but as a critical stage in strengthening the national economy.

The efficiency of the aforementioned investments and their direct impact on the school retention of children with SEN represent, in fact, the foundation for the impact of investment on long-term economic growth. This demonstrates how educational efforts transform over time into concrete economic benefits by increasing productivity and labor market participation. The correlation between education and labor productivity maximizes each individual's potential, regardless of their abilities. In the modern economy, productivity is closely linked to cognitive and socio-emotional skills. Early investments in an inclusive economy prevent the phenomenon of marginalization, which would otherwise generate high social costs in the future.

While the economic arguments presented demonstrate the strategic value of inclusion at both global and national levels, the Republic of Moldova depends directly on budget management at the local level. Currently, the inclusive system in the Republic of Moldova is moving beyond the experimental stage, becoming a structural component of general education through the expansion of **Resource Centers for Inclusive Education (CREI)** in all institutions with beneficiaries. This is supported by the implementation of the **Program for the Development of Inclusive Education 2022-2027** and the monitoring of children's progress by the **Psychopedagogical Assistance Service (SAP)**.

Budgetary analyses demonstrate a direct correlation between per-pupil funding, inclusion coefficients, and the reduction of dropout rates among students with SEN. Following this progress, a practical reality emerges that may limit long-term economic impact: the lack of adapted infrastructure, a deficit of specialists, social stereotypes, and the migration of trained specialists to other sectors. As a development perspective, the future of inclusion in the Republic of Moldova requires a classroom presence through digitalization, expenditure optimization, and rigorous monitoring of results, ensuring the efficient use of public funds.

Here is the professional English translation of your conclusion, ensuring academic coherence and the correct use of economic and educational terminology.

Conclusions

In conclusion, it is important to emphasize that **inclusive education** is not merely an act of social justice, but also a high-yield economic investment. Investing in the education of children with Special Educational Needs (SEN) and those from vulnerable groups transforms potential social assistance recipients into active taxpayers, thereby increasing labor productivity and economic resilience. The Republic of Moldova has taken significant steps by establishing **Resource Centers for Inclusive Education (CREI)** and aligning its legislation with EU standards. However, economic efficiency remains hindered by infrastructural barriers and a shortage of specialists. It has been demonstrated that the "cost of exclusion" far outweighs the investment required for inclusion. Cost-benefit analyses indicate that retaining students within the school system through tailored support reduces the long-term budgetary burden.

Based on this analysis, we have identified a clear economic return—a strategic investment capable of transforming potential welfare beneficiaries into active contributors, reducing the long-term fiscal burden through:

- **Early investment**, which maximizes individual potential and boosts labor productivity.
- **Institutional progress** in the Republic of Moldova, which has consolidated the legal framework, correlated specific funding, and increased the school retention rate of students with SEN.
- **The validation of international models** (Dual, Scandinavian), which confirms that economic success expands in direct proportion to the degree of integration of vulnerable groups.

While this research provides clarity, certain **limitations** must be highlighted:

- The absence of long-term longitudinal studies tracking the professional trajectory of students through to their full integration into the labor market.
- The difficulty of reflecting social cohesion within standard economic indicators (e.g., GDP).
- The concentration of resources in urban areas and the resulting isolation of rural communities.

These limitations underscore the need for a more nuanced approach, moving from analytical constraints to operational challenges. The gap between theory and practice is tested by structural and social hurdles that may limit the estimated long-term economic impact. To further the research and deepen the subject, the following future directions are proposed: the **digitalization of inclusion, continuous teacher training, and fiscal sustainability**.

In conclusion, the Republic of Moldova is at a turning point. If investments in inclusive education are maintained and optimized, the country will succeed not only in upholding human rights but also in substantially fortifying its economic foundation. The transition from a system of assistance to one of **empowerment** represents the most reliable path toward sustainable economic growth and a truly prosperous society.

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TRANSFORMING HUMAN RESOURCE MANAGEMENT FOR UNLOCKING BUSINESS EFFICIENCY

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Abstract: *The increasing complexity of the business environment forces organizations to rethink their management models, particularly with regard to human capital. In this context, human resource departments have assumed a strategic role in achieving competitive advantages and generating long-term value. Based on this premise, the present study focuses on analyzing how people management influences key variables such as economic performance, customer perception, and corporate image.*

To this end, the study is grounded in a theoretical review that allows for the identification of the main human resource practices with organizational impact, including internal promotion, training, inclusion policies, work-life balance, compensation systems, and ethical principles in the workplace. At the same time, the role of technology in organizational transformation is incorporated into the analysis, assessing its potential contribution both to business performance and to the achievement of sustainability criteria, measured through ESG indicators. Additionally, operational human resource variables are considered, such as employee turnover, employee satisfaction, productivity, and labor costs.

Unlike much of the existing literature, which tends to focus on specific sectors and relies on cross-sectional data, this study adopts a broader and more dynamic perspective. Specifically, longitudinal data will be used to observe the evolution of the variables over time, allowing for a more comprehensive understanding of the proposed relationships. Furthermore, the sample will consist of publicly listed companies from different geographical contexts—both European and international—in order to capture the influence of institutional and cultural factors.

The present research aims to deepen the existing knowledge of the proposed relationships in order to overcome the limitations identified in the literature. In this regard, the results will enable a better understanding of human capital management, contributing not only to the improvement of organizational functioning, but also to the strengthening of competitiveness and organizational development, while generating shared value among all stakeholders.

Key words: *Human Resource Management, Customer Satisfaction, Financial Performance, Sustainability*

JEL: M12, M15, M14

Introduction

In a global context characterized by increasing social and environmental concerns, together with the development of governmental regulations, organizations face significant challenges in their attempts to optimize their human resource management practices. From a social perspective, employee well-being represents a challenge for both public and private organizations (Burón and Minaya, 2024). Furthermore, the labor environment is deeply affected by external factors that introduce constant changes in planning, among which innovation and the use of technology stand out. Procedures and tasks within organizations are evaluated in search of technological innovations, identifying processes with potential for digitalization and measuring their impact in terms of sustainability (Gómez-Limón et al., 2024; Midolo-Ramos et al., 2024) and productivity.

The changes that have taken place over the last decade in the labor context represent a transformation of the business fabric, comparable to the technological revolutions of the past (BlackRock, 2024). This new environment and the constant adaptation to it have generated significant interest in the study of Human Resource (HR) practices and their impact on performance (Almehairbi and Mosali, 2022) and business competitiveness (Bolatan et al., 2022).

On the other hand, an appropriate HR management policy contributes to the creation of a suitable work environment, with more motivated, committed, and satisfied employees. A positive work environment could significantly increase service quality, the level of loyalty of current customers, and the ability to attract new customers (Mitašiūnaitė, 2021). Conversely, when consumers identify and communicate negative incidents related to environmental, social, and governance (ESG) criteria, it is considered that they are highlighting an ESG controversy.

These controversies may arise from business practices that do not comply with ESG standards and are frequently covered by the media, which can influence public perception (corporate reputation) and the company's market value. In the previous literature review conducted by Pascua and Japos (2023), the need to analyze whether HR practices improve the purchasing experience and customer satisfaction is identified. In chapter two of the doctoral thesis, several research questions are raised regarding the impact of human resource management on customer experience.

Furthermore, the impact derived from technological change will depend on its degree of complementarity with workers and the functions performed in their jobs. Previous studies have shown that digitalization has positive impacts on organizations, such as increased profitability (Bienhaus and Haddud, 2018), cost reduction (Seete, 2022), and the establishment of a competitive advantage (Pfister and Lehmann, 2021). However, there are also studies that have highlighted the possible adverse effects of technology, both on workers—through increased stress (Ferrari et al., 2023) and a decrease in their communication skills (Todorova and Georgieva, 2023)—and on the organization as a whole, due to the emergence of security and privacy issues (Turel et al., 2021). Therefore, it is essential to focus attention on human capital in order to maximize the positive effects of these advances both at the organizational level and in the social environment (Jimeno and Lamo, 2024).

Among the positive effects brought about by the digitalization of organizations through the incorporation of technological advances, its contribution to sustainability stands out. This impact can be explained through "an increase in efficiency, greater job security, reduction of errors and waste, lower environmental impact, and greater flexibility and adaptability" (Clalib, 2023). It is undeniable that technology and sustainability are deeply interconnected, to the point that a new concept has emerged in the literature: "Industry 5.0." This term refers to a new business model based on collaboration between humans and machines (Travez and Villafuerte, 2023), and "centered on the human being, sustainability, and resilience" (European Commission, 2021).

As can be observed, the challenge faced by organizations no longer lies in deciding whether they should adopt sustainable practices, but rather in determining how they can effectively implement sustainability strategies and how to put them into practice. This paradigm shift highlights the particular relevance that sustainability has acquired today, positioning itself as a central global priority. In this regard, it is worth highlighting the Sustainable Development Goals (SDGs), included in the 2030 Agenda and approved by the United Nations in 2015. These objectives aim to achieve a sustainable future through equality and the protection of the planet (United Nations, 2023).

Based on the arguments presented, this doctoral thesis aims to conduct an in-depth study and analysis of the impact of human resource management on business outcomes and customer experience, comparing these effects across different countries, both within and outside the European Union. Likewise, it seeks to examine the influence of the incorporation of new technological advances on human capital and sustainable development.

Basic content.

Objectives

The objective of this research is to provide organizations with a comprehensive framework to support strategic decision-making in the field of human resource management, which not only allows maximizing organizational development but also contributes to ethical, socially responsible, and sustainable management. To this end, the impact of human resource management practices, as well

as their level of implementation and quality of management, on organizational performance and customer satisfaction will be analyzed. Likewise, the possible relationship between the degree of technological innovation present in organizations and their human resource management indicators and sustainable development will be examined. Specifically, the main objectives of the research are:

- To analyze and identify the human resource practices that enable companies to adopt an orientation toward superior organizational performance, as well as to understand their evolution over time in both the short and long term
- To explore the possible link between the working conditions present within the organization and the final customer experience and satisfaction
- To study the possible relationship between customer satisfaction and economic-financial performance
- To analyze the influence of technological innovation on business management processes, with special emphasis on its impact at the organizational and market levels
- To explore the possible link between the degree of technological innovation implemented in organizations and compliance with ESG criteria
- To build a solid framework that serves as progress in guiding companies toward socially responsible management, aligned with new technological advances, sustainable development, and compliance with the 2030 Agenda.

With the aim of providing greater clarity and understanding of the objective of this research, the relationships under study are presented graphically below. It should be noted that the proposed relationships between the variables will be analyzed in depth and do not constitute single hypotheses. In Model 1, corresponding to Chapters 1 and 2, the link between human resource management policies and practices (growth and promotion opportunities, training and development, diversity and inclusion, work-life balance, social benefits, and work ethics), financial performance, and customer satisfaction will be analyzed, as well as the possible relationship between these variables.

For the measurement of the financial performance variable, ROA (return on assets), ROE (return on equity), and EBITDA margin will be used. On the other hand, customer satisfaction will be measured directly through a satisfaction percentage. In the following image (Figure 1), the main relationships under study among the proposed variables can be observed graphically.

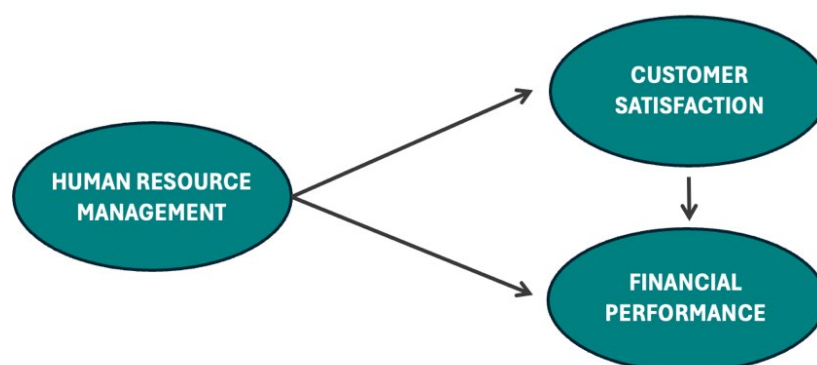


Figure 1: Relationships under study in Model 1

Source: Own elaboration

In Model 2, corresponding to Chapters 2 and 3, the relationship between the degree of technological innovation, the indicator variables of human resource management, and sustainable development will be investigated. For measuring the degree of technological innovation, proxy variables that may represent this indicator are being explored, such as the level of innovation and development. In

contrast, for the human resource management indicator variables, as mentioned, staff turnover, employee satisfaction, staffing needs, productivity, and labor cost, among others, will be used. Finally, ESG criteria will be employed to measure sustainable development. In the following image (Figure 2), the relationships proposed between these variables can be observed graphically.

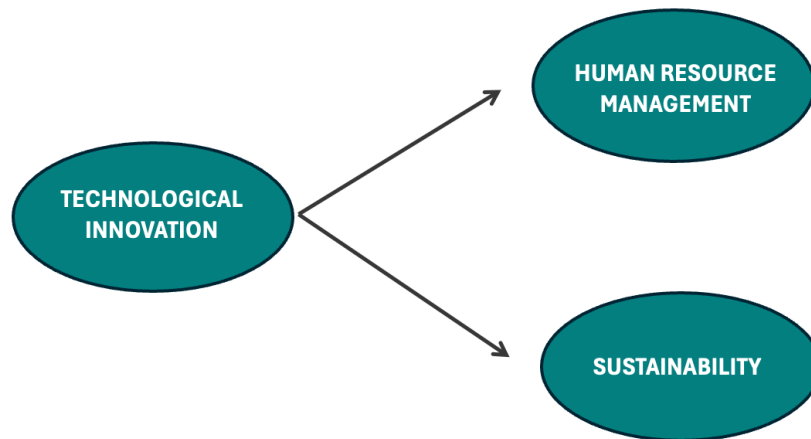


Figure 2: Relationships under study in Model 2

Source: Own elaboration

Methodology

Exploratory Research

In the first stage of the research, an analysis and review of the literature will be carried out in order to understand and identify the current state of research on the topics addressed. In this way, the limitations found in previous studies, as well as future research areas, will be identified.

Data Collection and Processing

To analyze the relationships between the proposed variables, longitudinal databases will be used, specifically LSEG Workspace (formerly known as Refinitiv Eikon or Datastream), currently managed by London Stock Exchange Group. This database represents one of the largest providers of financial market data and infrastructure in the world. This decision is based on the fact that the main objective of this research is to analyze and study the relationships between these variables over time, rather than the relationships existing at a specific point in time. In this way, by using objective data, exposure to individual biases will be avoided, enabling the use of more robust statistical techniques. Furthermore, the use of this database will allow observation of the evolution of these variables over time, making it possible to identify trends and temporal differences.

Empirical Data Analysis

The methodology used for the analysis of longitudinal data will be panel data analysis, through which it will be determined at the appropriate time whether the model developed is better suited to a static or dynamic model.

Conclusions.

The findings of this research will provide organizations with an empirical basis to guide strategic decision-making in human resource management, tailored to their specific needs, in relation to financial performance, customer satisfaction, digitalization, and sustainability. In this way, a comprehensive framework will be provided that will enable organizations to maximize their development and organizational success, while contributing to the generation of shared value among all stakeholders.

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SECTION 4: FINANCE

MOLDOVA VS ROMANIA: A TRANSFER PRICING PERSPECTIVE

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Abstract: *The importance of the transfer pricing topic has grown increasingly in the past years, due to globalization process and the expansion of multinational business structures. As cross-border intra-group transactions intensify, national tax systems face growing challenges in ensuring compliance with the arm's length principle and preventing base erosion. This article undertakes a comparative analysis of the transfer pricing frameworks in the Republic of Moldova and Romania, highlighting both similarities and structural differences in their legal and administrative approaches. While scientific literature extensively addresses transfer pricing in developed economies and EU Member States, comparative studies involving emerging or transition economies remain relatively rare. By examining the Moldovan and Romanian experiences, the article contributes to the academic debate on regulatory convergence, enforcement capacity, and the practical effectiveness of transfer pricing rules in differing institutional contexts. Thus, the paper itself focuses on qualitative research, by comparing the legal framework governing transfer pricing in both countries. The results have shown that although the legislation of the Republic of Moldova and Romania is comparable in terms of principles and objectives, it is not fully equivalent from a functional point of view. Comparability is more theoretical and normative than practical, requiring taxpayers and multinational groups to adopt differentiated approaches to compliance and tax risk management, tailored to the specificities of each jurisdiction.*

Key words: *transfer pricing, arm's length principle, associated enterprises, documentation*

JEL: H25, H32, K34.

Introduction

International transfer pricing regulation has developed progressively, starting from the initial recognition of the need to protect the tax base and leading to a complex framework developed by the OECD/G20, which includes the arm's length principle – ALP), detailed guidelines such as the OECD Guidelines, and the latest BEPS (Base Erosion and Profit Shifting) initiatives, aimed at limiting aggressive tax optimization. This evolution has led to the introduction of rigorous documentation requirements (Local File, Master File, Country by Country Reporting) and debates on the taxation of the digital economy, with the aim of harmonizing practices globally and increasing the transparency of transactions between affiliated entities.

At the regional level, Central and Eastern Europe offer numerous examples of interactions between economies on different paths of fiscal convergence but deeply connected economically. In this context, the relationship between the Republic of Moldova and Romania is distinguished by a high degree of trade and investment interdependence, as well as an increasingly significant volume of intra-group transactions. Groups of companies operating in both jurisdictions frequently structure flows of goods, services, financing, or intellectual property rights, which places transfer pricing issues at the centre of the tax risks associated with these cross-border relationships.

The comparison between Moldova and Romania from a transfer pricing perspective is not arbitrary but reflects an economic and fiscal reality that is increasingly relevant for the region. The two countries are deeply interconnected through trade and investment relations, with Romania being one of Moldova's main economic partners. In recent years, there has been a steady increase in the number of groups of companies conducting cross-border activities between the two jurisdictions, particularly through holding structures, operating subsidiaries, service centres, or production and distribution entities. This dynamic generates a significant volume of intra-group transactions, which places transfer pricing issues at the centre of taxpayer's tax concerns.

Although Moldova and Romania share many cultural, linguistic, and business practice similarities, the fiscal framework and maturity level of transfer pricing legislation differ significantly. Romania has a consolidated transfer pricing regime, aligned for several years with the OECD Guidelines, with clear documentation requirements and a well-developed tax control practice. In contrast, the Republic of Moldova is in an accelerated process of harmonization with international standards, and the regulatory framework and administrative practice in the field of transfer pricing are still evolving. This combination of similar business models but different tax rules create a fertile ground for adjustment risks and divergent interpretations of the arm's length principle.

Intra-group transactions between Moldova and Romania are frequently subject to scrutiny by tax authorities, particularly about intra-group services, financing, royalties, and profit margins applied. Differences in approach between the two tax administrations can lead to transfer pricing adjustments and, implicitly, to double taxation risks, issues that are becoming increasingly relevant amid intensified tax controls and growing compliance requirements.

Therefore, a "Moldova vs. Romania" analysis from a transfer pricing perspective goes beyond a simple theoretical comparison of two tax systems and becomes an exercise of major practical relevance for corporate groups, tax advisors, and investors active in the region. This comparison highlights a veritable regional transfer pricing laboratory, where transaction frequency, regulatory differences, and intensified tax controls make transfer pricing an essential topic for tax risk management and ensuring long-term compliance.

Methodology

The research question of this paper is as follows: *What are the main similarities and differences between Moldovan and Romanian legislation on transfer pricing, from the perspective of alignment with the arm's length principle and Organization for Economic Co-operation and Development's (OECD) standards?*

In this context, qualitative research was performed, based on the transfer pricing legal framework, both in Moldova and Romania.

The general hypothesis underlying the research is as follows: *there are significant differences and similarities between the legislation of the Republic of Moldova and that of Romania in the field of transfer pricing, which can be identified and analysed through a comparative approach to the relevant legal standards.*

Analysis performed

1. Implementation of transfer pricing regulations

Formal transfer pricing laws were implemented by the Moldovan Tax Code and went into force on January 1, 2024. Implementing the transfer pricing concept in the Republic of Moldova involves a complex process of aligning local legislation with the OECD Guidelines.

Also, the Ministry of Finance of Moldova approved and published on 26 January 2024 the secondary legislation on transfer pricing rules implementation, consisting of Order No. 9.

In Romania, the arm's length principle was implemented in 1994, in the national tax legislation, however the legislative formalization of transfer pricing in Romania only began in the 2000s. (Feleaga, Neacsu, 2016, p. 128) In 2016, starting January 1, new tax legislation comes into force, Order No. 442, an improved version of the 2008 Order, which treats the subject of transfer pricing with increased attention.

2. Main concepts definition

In the transfer pricing area, there are certain concepts that are internationally recognized and commonly applied, forming the conceptual basis for national regulations and guiding the interpretation and implementation of transfer pricing rules at domestic level. Among the most relevant are the arm's length principle and the notion of associated enterprises.

The *arm's length principle* (ALP) requires multinational enterprises to price transactions performed between headquarters and their affiliates as if they were independent companies, using market-based comparisons. (Choi, et.al, 2020, p. 2)

In the tax code of the Republic of Moldova (chapter 112, article 226¹⁷), as well as in Romania (title 1, chapter 3, article 7), the definition of the arm's length principle is aligned with the OECD Guidelines.

Regarding the associated enterprise concept, there have been found few differences. As the definition provided in the OECD Model Tax Convention is a general one, further, each jurisdiction should establish the threshold for affiliation, defined in each country's law.

Moldova and Romania both follow the 25% minimum threshold for the affiliated party definition. The difference in the definition of the related party is the degree of relatedness. In Romania, "an individual person is affiliated with another individual if they are spouses or relatives up to and including the IIIrd degree" at the same time, in Moldova "an individual person is affiliated with another individual if they are spouses or relatives up to and including the IInd degree".

Given that affiliation also arises because of control exercised by either an individual or a legal entity, it is necessary to examine the similarities and differences regarding the concept of control.

In Romania, a person is considered to have effective control over a legal entity when the person who manages or administers an entity has both legal and factual decision-making power. Decision-making power may result from the use of relevant information and/or documents, from transactions with other legal persons under common control, or from the fact that the person in charge is a shareholder or director of the entity concerned.

Decision-making authority may result from the use of relevant information and/or documents, from transactions with other legal entities under common control, or from the fact that the manager is a shareholder or director of the entity concerned.

Contracts concluded between the parties involved, as well as rights granted by articles of association, powers of attorney, individual employment contracts, or service contracts, are considered to demonstrate that effective control exists.

On the other hand, in Moldova, a person is considered to exercise effective control over a legal entity when it is established that, from a legal and factual point of view, they have decision-making power over its activities. This power may mainly manifest itself in the ability to appoint or dismiss most of the members of the supervisory or management bodies, including the executive body or the control bodies.

Effective control may also result from the exercise of rights conferred by a contract concluded with the legal entity, by clauses provided for in its articles of association or statutes or based on an agreement concluded with other persons holding voting rights in that entity.

Fundamentally, both definitions convey the following concept: control exists when a person, directly or indirectly, legally and factually, has the power to make decisions regarding the activities of a legal entity.

3. Transfer pricing methods

The transfer pricing methods are defined in the Chapter II of the OECD Guidelines. According to it there are five transfer pricing methods, but also, OECD allows to use other methods as well. Thus, the figure below shows the methods approved by Moldovan and Romanian legislation regarding transfer pricing.

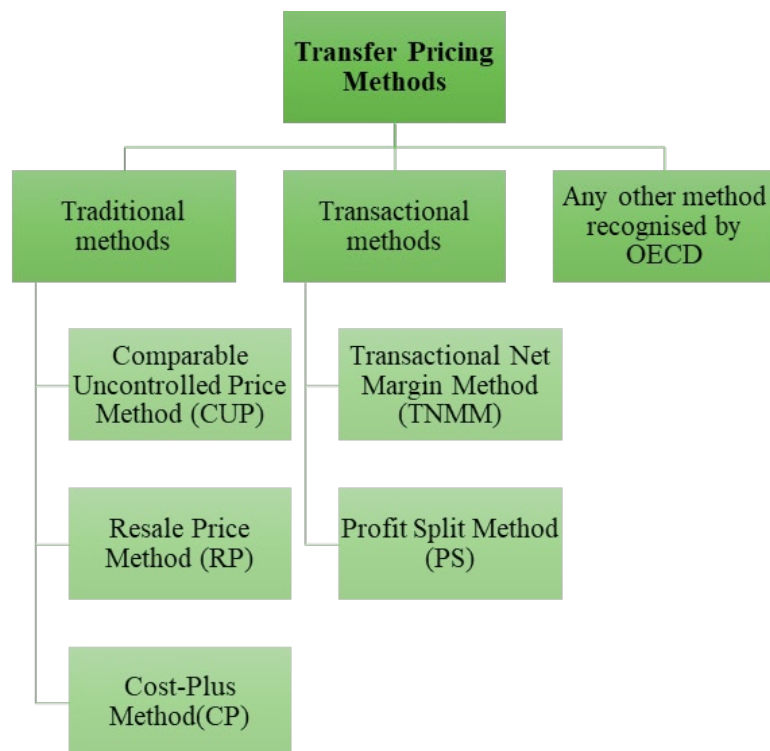


Figure 1. The methods approved by Moldovan and Romanian legislation regarding transfer pricing

Source: own processing

In Romania, the methods are described directly in the tax code, while in Moldova the methods are described in Order No. 9 of January 26, 2024.

4. Documentation

To show / sustain that an intragroup transaction satisfies the arm's length principle, a taxpayer must provide documentation in connection to the transaction performed. Thus, tax administrations have adopted certain rules for documentation, the same applies to Romania and Moldova.

The Figure 2 below shows the materiality thresholds for taxpayers to document transfer prices, on the one hand in Moldova and on the other hand in Romania:

Moldova	Romania
• The transactions performed with the affiliated parties, in a tax period, with a total equal or greater than 20,000,000 MDL, VAT excluded, should be documented by the taxpayer through transfer pricing documentation, meaning transfer pricing file, submitted to the State Tax Service.	• An annual transfer pricing file must be prepared by large taxpayers who engage in transactions with affiliated persons whose total annual value - which is determined by adding the value of transactions with all affiliated persons, excluding VAT, is equal or greater with the following thresholds: • 200,000 EUR, for interests paid/received; • 250,000 EUR, for services received / provided; • 350,000 EUR, for sales / purchase of tangible or intangible assets. • For taxpayers who do not fall into the category of large taxpayers, the following materiality thresholds are applicable: • 50,000 EUR, for interests paid/received; • 50,000 EUR, for services received / provided; • 100,000 EUR, for sales / purchase of tangible or intangible assets. • If the transaction values are below the materiality thresholds, documentation of compliance with the arm's length principle for intragroup transactions will be provided at the request of the tax authority during the tax inspection. • Note! For materiality thresholds, the equivalent in RON will be calculated according to "the exchange rate communicated by the National Bank of Romania valid for the last day of the fiscal year."

Figure 2. Materiality thresholds for transfer pricing documentation

Source: own processing

As can be seen in Figure 2, in Moldova, materiality thresholds are regulated in a relatively simplified manner and are used primarily to determine the obligation to prepare transfer pricing documentation. Therefore, the approach of the tax authorities is to focus on transactions that are significant in terms of value.

On the other hand, in Romania materiality thresholds are set separately and differ depending on the type of taxpayer and the nature of the transaction. This structure reflects a sophisticated approach, aimed at adapting documentation requirements to the risk profile of each taxpayer.

Relevant to this comparative analysis, also, are the deadlines for submitting/presenting transfer pricing information, as shown in Figure 3:

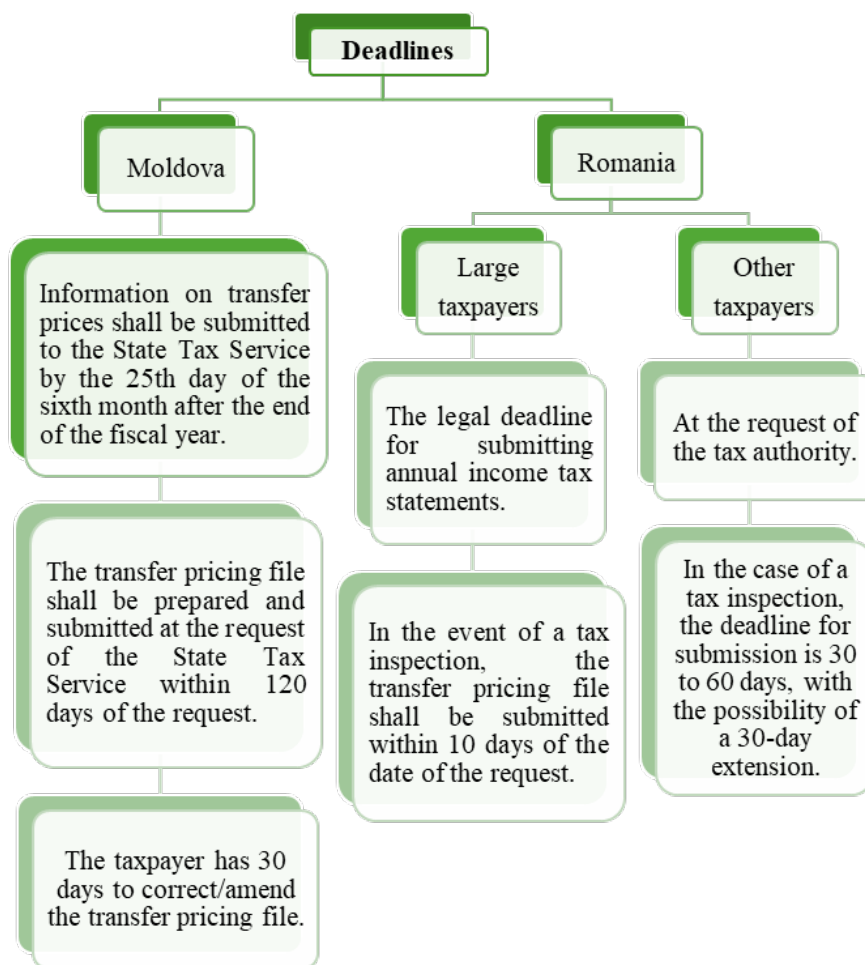


Figure 3. Deadlines for transfer pricing documentation

Source: own processing

From the information presented above, it appears that Moldovan legislation is more flexible in terms of preparation, submission, and presentation deadlines. In Moldova, the obligation to prepare and submit transfer pricing documentation is reactive in nature, being triggered exclusively at the express request of the tax authority. The taxpayer is not required to submit the documentation automatically within a fixed period after the end of the fiscal year but must submit it within the period set by the State Tax Service.

Romanian legislation establishes a more structured and predictable regime, based on pre-established deadlines that vary depending on the taxpayer category. For certain categories, especially large taxpayers, the obligation to have the transfer pricing file prepared is linked to a fixed deadline related to the end of the fiscal year, even if the actual presentation usually takes place in the context of an audit.

Following the analysis performed, the research hypothesis has been totally validated. A comparison of transfer pricing legislation in the Republic of Moldova and Romania reveals substantial alignment in terms of principles, with both systems built around OECD standards and the arm's length principle. However, conceptual similarity does not automatically translate into full comparability of legal regimes, as the specific methods of implementation and enforcement of obligations differ significantly between the two jurisdictions.

Conclusion

Since, Moldova is still consolidating its transfer pricing legislation and administrative practice and Romania an EU Member State, with a relatively mature transfer pricing framework, comparative research on the transfer pricing perspective both in Moldova and Romania helps identify regulatory gaps, convergence trends etc.

Also, Moldova and Romania face distinct but related challenges in safeguarding their tax bases while remaining competitive in attracting foreign investment, thus the subject is of high importance.

Research on transfer pricing in Moldova and Romania is particularly relevant for the academic field. Firstly, such research contributes to comparative examinations of how international standards are transposed and adapted within different legal, institutional, and economic contexts. Romania and Moldova provide a compelling comparison: one is an EU Member State with a relatively mature and formalized transfer pricing regime, while the other is a non-EU country in a process of gradual alignment.

Secondly, studying Moldova and Romania enables academics and practitioners to assess how institutional capacity, audit practices, and dispute resolution mechanisms influence the practical functioning of transfer pricing regimes.

Finally, research in this area has strong interdisciplinary relevance as transfer pricing directly affects investment flows, corporate governance, and tax compliance behaviour, making it a key subject for economists, public finance and researchers.

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TURBULENT GLOBAL LANDSCAPE: AN ANALYSIS OF CHINA'S RARE EARTH EXPORTS

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Abstract: *As a key resource for promoting industrial development, climate governance and energy transition, rare earth (RE) has become a new focal point in geopolitical games. This paper incorporates geopolitical risk (GPR) and China's rare earth export (REE) amount into a unified framework and utilizes the rolling-window Granger causality test to investigate their dynamic relationships. The findings demonstrate that GPR transmits positive shocks to REE. This favorable impact implies that geopolitical events can increase countries' concerns about RE supply disruptions and expand their strategic reserves. Then, the rise in demand has played a crucial role in promoting REE. This outcome highlights the importance of GPR in enhancing sustainable REE during turbulent eras. In contrast, REE exhibits a negative impact on GPR. The main reason is that the rise in RE supply alleviates military wars and the tense geopolitical situations caused by resource competition, contributing to the stability of the global geopolitical environment. In the context of worldwide geopolitical turmoil, these findings provide valuable guidance for policymakers and investors to maintain the stability of REE and apply effective risk management methods in responding to GPR impacts.*

Key words: *Rare earth elements; Rare earth exports; Geopolitical risk; Time-varying; Granger causal relation*

JEL: Q21; Q58

Introduction

This article probes China's rare earth export (REE) amount during periods of volatile geopolitical risk (GPR) and further examines whether sustainable REE can be seen as a pivotal strategy for mitigate turbulence. As essential industrial vitamins and strategic resources of the 21st century, the wide application of rare earth elements (RE) holds notable economic and environmental value (Zhang et al., 2022; Liu et al., 2025). On one hand, RE holds a key position in traditional industries (e.g., glass and metallurgy) as well as high-tech industries (e.g., military, defense and medical sectors) (Xu et al., 2024; Zhang et al., 2024a). On the other hand, RE is an indispensable element in clean energy fields, such as new energy vehicles, solar panels and wind power, providing momentum for accelerating the global low-carbon transition (Gao et al., 2024; Liu et al., 2025). In recent years, geopolitical events such as Brexit, the Sino-U.S. trade friction and the Russia-Ukraine conflict have accelerated the fragmentation of the geo-economy and increased the vulnerability of the global RE supply chain. Specifically, geopolitical games and military conflicts can destroy the RE production facilities of supplying countries, block transportation channels and impact the sustainability REE through higher tariffs and shipping costs (Zhou et al., 2022; Zhang et al., 2024b). In addition, the high unpredictability of GPR amplifies investors' concerns about the RE market and prompts them to adopt conservative strategies of delaying investment (Liu et al., 2025), further hinders the rise in REE.

Some studies have investigated the factors influencing the RE market, including economic policy uncertainty (Li et al., 2023), climate policy uncertainty (Wang et al., 2025), renewable energy consumption (Ding et al., 2024; Zhang and Jiang, 2025) and oil price uncertainty (Li et al., 2026). However, the impact of GPR shocks on REE has received little attention. Against the background of the constantly changing global geopolitical landscape, exploring the bidirectional relationship between the two variables can help determine whether GPR is a driving or limiting factor for REE and provide valuable insights for the Chinese government in formulating RE supply policies.

In the global RE industry landscape, China possesses the largest reserves and the most complete industrial chain system (Guo and Liu, 2025; Li et al., 2026). With lenient environmental policies and massive investments, China has controlled 90% of the world's RE refining capacity (Ambrose, 2025). This processing bottleneck strengthens other countries' dependence on RE imports (Fan et al., 2023; Kang et al., 2025) and creates conditions for China to use RE as a tool of geopolitical coercion (Woods, 2025). For example, the outbreak of the 2010 Diaoyu Islands dispute leads China to stop exporting RE to Japan. This diplomatic crisis triggered by a maritime dispute increases global concerns about China's monopoly on RE and exacerbates the rise of GPR (Depraite and Goutte, 2025). In 2025, China has implemented export control measures on heavy RE as a retaliation against the high tariffs imposed by the U.S. (Li et al., 2026). This move sparks investors' concerns about disruptions in RE trade and leads to significant volatility in the U.S. stock market. Therefore, China can use RE as a political weapon to ease conflicts with other countries. However, China's RE industry faces the dual challenges of sustainable development and supply stability (Diao et al., 2024). On the one hand, incomplete industrial policies and regulatory measures have resulted in a large amount of illegal RE mining activity. Unregulated extraction and processing activities have caused severe environmental damage, including water, soil and air pollution, posing additional risks to biodiversity and human health (Diao et al., 2024). On the other hand, as the largest developing country in the world, China's RE market is highly susceptible to profound impacts from global changes (Li et al., 2025). With the continuous escalation of the limited supply dilemma, geopolitical conflicts and trade protectionism can disrupt RE supply and further complicate China's RE market (Han et al., 2025). Given China's dominant position in the global RE market, examining their correlation can deepen our understanding of GPR's role in shaping the RE market and provide valuable insights for Chinese policymakers to maintain the stability of REE.

The marginal contributions of this paper can be summarized in three points. First, with the global transition to clean energy and advanced technologies, the importance of RE has become increasingly prominent (Han et al., 2025). In this context, ensuring a sufficient and stable supply of RE has become an important issue. China is a leader in the global RE production and processing sector, and its stable exports play a crucial role in maintaining supply chain security (Li et al., 2026). This paper places GPR and REE within the same analytical framework, which is significant for understanding the factors affecting the stability of RE supply and formulating effective export policies. Second, extant research predominantly delves into the unidirectional impact of GPR on RE prices (Fan et al., 2023; Li et al., 2023) or export amounts (Chen et al., 2025; Islam, 2025). However, the role of REE in GPR has not yet been explored. Therefore, this paper comprehensively examines the bidirectional causal relationship between GPR and REE to fill this research gap. Third, panel regression method and traditional vector autoregression (VAR) model examine the relationship between GPR and REE from a static perspective and cannot assess their nonlinear and time-varying effects. In this paper, the application of the bootstrap rolling-window Granger causality test can capture structural changes and time-varying characteristics caused by external shocks, further addressing the limitations of traditional econometric methods. The findings demonstrate that there is a bidirectional causality between GPR and REE, which is evident across multiple sub-samples. Specifically, GPR exerts a beneficial effect on REE during 2020: M4-2022: M3 and 2022: M9-2024: M2. This reflects that the turmoil caused by GPR helps promote the sustainable REE and RE can serve as a hedge against

geopolitical uncertainties. The negative effect of REE on GPR during 2014: M4-2014: M7 and 2015: M3-2015: M11 indicates that a stable supply of RE has the potential to mitigate geopolitical tensions. In contrast, the decline of REE triggers market concerns about supply disruptions and expands their strategic reserves. Therefore, intensified competition for RE will lead to higher GPR. These conclusions can provide important insights for governments and investors in formulating effective policy measures and risk management strategies.

Basic content

The mechanisms linking GPR and REE are summarized in Figure 1.

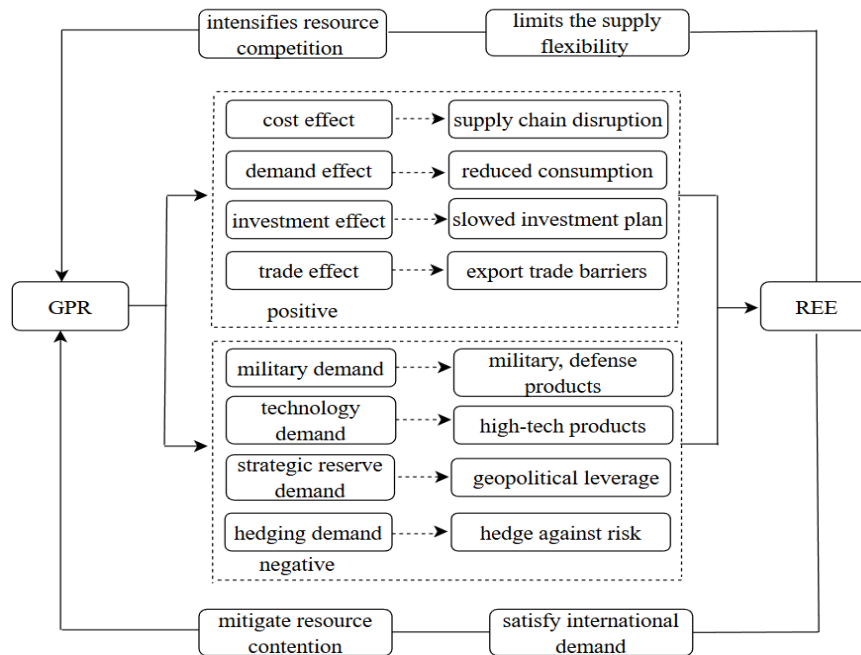


Figure 1. The transmission mechanisms of GPR and REE.

Source: Illustrated by the author

The adverse effects of GPR on REE can be summarized in four points. First, the cost effect. GPR increases transportation costs and transaction costs by disrupting shipping routes and logistics systems (Zhang et al., 2024a; Huang et al., 2025; Sanglier-Contreras et al., 2025). This makes it more difficult for exporting countries to deliver RE products and poses potential risks of supply chain disruption (Mariev and Blueschke, 2025). Second, the demand effect. The turmoil and uncertainty triggered by GPR weaken investor confidence and increase their risk aversion (Zhang et al., 2024b). Therefore, a substantial decrease in global consumption and demand negatively impacts REE. Third, the investment effect. Turbulent geopolitical situations can trigger risk-averse sentiments among companies and investors, leading them to delay or cancel RE-related production activities and investment plans (Zhao et al., 2025). Besides, the worsening of financing difficulties poses a serious threat to the normal production and stable supply of RE (Zhang and Jiang, 2025). Fourth, the trade effect. Rising GPR disrupts trade between supplying countries and importing countries, inhibiting the development of REE trade (Braunstein and Chuchko, 2025; Han et al., 2025). As a result, the strengthening of trade barriers poses a significant threat to REE.

The positive influence of GPR on REE can be attributed to four points. First, the military demand. The military and defense industries have substantial demand for RE during periods of military competition and geopolitical conflicts (Li et al., 2023; Wang et al., 2025), thereby creating favorable conditions for REE growth. Second, the high-tech products demand. The shift from traditional warfare to new forms such as technological embargoes and sanctions will drive the demand for RE in high-tech products (Zhang and Zhu, 2023; Wang et al., 2025). This is conducive to promoting the

sustainable development of the RE industry and growth in exports (Wang et al., 2025). Third, the strategic reserve demand. The high level of GPR can heighten concerns among countries that China may use RE as a geopolitical leverage (Depraeter and Goutte, 2025). This prompts countries to stockpile RE extensively and drives substantial growth in REE. Fourth, the hedging demand. Geopolitical events can undermine the purchasing power and safe-haven value of currencies. As a result, investors channel large amounts of capital into the RE market to hedge against GPR, which facilitates the growth of REE (Li et al., 2023). This paradoxical phenomenon indicates that the relationship between GPR and REE is not constant but is influenced by multiple factors. Accordingly, we propose the following research hypothesis:

Hypothesis 1: GPR has an inhibitory effect on REE.

Hypothesis 2: GPR has a promoting effect on REE.

REE exerts a negative influence on GPR. This is because the complexity of RE mining, refining and processing means that only a few RE deposits are economically viable for extraction (Gao et al., 2024; Oka, 2025). Currently, global RE reserves are extremely unevenly distributed, with a few countries controlling a large number of primary deposits (Fan et al., 2023). This unequal distribution of resources enables supplying countries to dominate RE pricing and export amounts (Fan et al., 2023; Oka, 2025), and turns the competition for RE into a central battleground in global geopolitical games (Lin and Zhang, 2025; Mariev and Blueschke, 2025). Accordingly, stable REE supplies are conducive to satisfying the rapid growth of international demand and mitigating geopolitical competition caused by resource contention. However, the decline in REE limits the supply flexibility of importing countries and intensifies competition for RE among nations. This could give rise to new forms of geopolitical conflicts over access to essential RE reserves. Accordingly, this paper proposes the following hypothesis.

Hypothesis 3: REE has an inhibitory effect on GPR.

This analysis uses monthly time series data spanning from 2012: M1 to 2025: M8, so as to detect the complex connection between GPR and REE. The rare earth exports amount² is adopted to gauge REE trends in China (Li et al., 2026). GPR refers to the uncertainty and potential threats in international relations caused by factors such as military conflicts, resource competition and geographical locations (Huang et al., 2025; Mariev and Blueschke, 2025). With the increasing complexity of the global geopolitical situation, GPR has emerged as a determinant influencing the fluctuations of REE. In this paper, we adopt the Geopolitical Risk Index developed by Caldara and Iacoviello³ (2022) as an evaluation indicator of the global geopolitical situation (Huang et al., 2025; Li et al., 2025; Lin and Zhang, 2025). In addition, this paper incorporates CPU and OP as control variables in the empirical analysis. The reason is that the adjustments in climate policy can have a profound impact on the extraction and refining processes of RE, thereby triggering changes in supply quantities. Moreover, the rise in OP drives up demand for clean energy and amplifies the demand for RE, thereby affecting the fluctuations of REE (Li et al., 2025). To this end, we use the Climate Policy Uncertainty Index⁴ developed by Gavriilidis (2021) to capture global climate policy trends (Wang et al., 2025). Besides, this paper uses West Texas Intermediate (WTI)⁵ as a proxy for global OP fluctuations (Liu et al., 2023). Figure 2 illustrates the trends of GPR and REE.

The bootstrap p-values of GPR on REE are shown in Figure 2. The p-values less than 0.1 indicate that the causal relationship of GPR on REE is significant during this period. The p-values greater than 0.1 imply that GPR does not affect REE. Clearly, GPR Granger causes REE at the 10% level during the periods 2020: M4-2022: M3 and 2022: M9-2024: M2, while no such causal impact is observed in other periods. Figure 3 reports the mean, maximum and minimum values of the impact coefficients

² These data are from Wind database.

³ These data are obtained from the <https://www.matteoiacoviello.com/gpr.htm>.

⁴ These data are from <https://www.policyuncertainty.com/>.

⁵ The data is selected by <https://cn.investing.com/currencies/wti-usd>.

of GPR on REE. The mean curve lying above zero indicates a positive impact of GPR on REE, and vice versa. During 2020: M4-2022: M3 and 2022: M9-2024: M2, GPR exhibits a positive impact on REE.

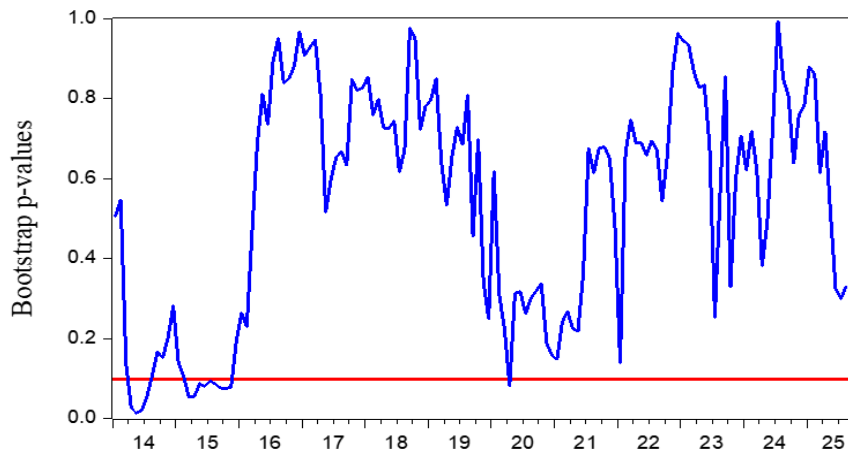


Figure 2. The p-values with no effect of GPR on REE.

Source: Generated using EViews software

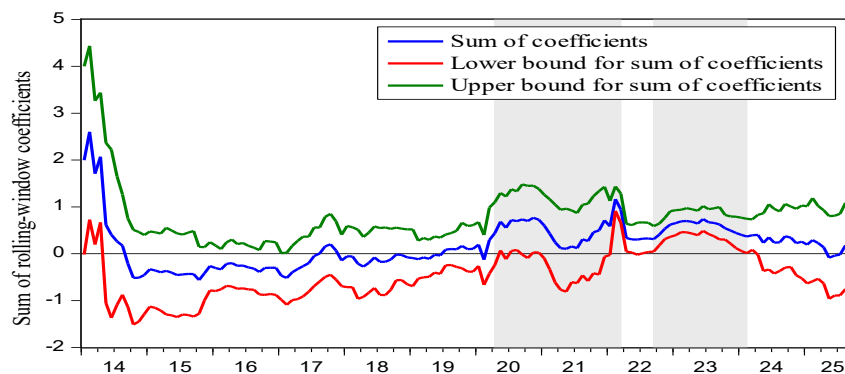


Figure 3. The influence coefficient of GPR on REE.

Source: Generated using EViews software

The positive impact of GPR on REE indicates that tense geopolitical situations enhance the strategic value of RE and promote sustainable growth in exports. The favorable connection between the two variables during 2020: M4-2022: M3 can be summarized in the following three aspects. First, since 2020, the Sino-U.S. trade war has entered a new phase of technological competition (Chang et al., 2025). The U.S. has placed multiple Chinese information and communication technology companies on the entity list and strengthened regulations on semiconductor exports, aiming to curb the development of China's semiconductor industry through the technological war. In response, China enacts the "Export Control Law of the People's Republic of China" in October 2020, aiming to strengthen control over REE as a form of retaliation. The introduction of this policy raises concerns among U.S. defense, new energy and other industries about the RE supply chain. The escalation of Sino-U.S. strategic competition leads GPR to remain at a high level (Wang et al., 2025). Subsequently, the spread of panic increases the global motivation to stockpile RE to prevent the negative effects of supply disruptions (Depraeter et al., 2025). Therefore, the surge in demand triggered by GPR becomes a significant driving force behind China's REE. Second, in March 2021, the leaders of the U.S., Japan, India and Australia have reached a strategic partnership, aiming to accelerate the development of RE refining technology and establishing self-sufficient mining and refining plans. Moreover, the U.S. attempts to accelerate the development of a new RE supply chain to reduce dependence on imports from China and counter its dominance in the global RE market. As geopolitical competition continues

to escalate, the strategic assets nature of RE has been unprecedentedly reinforced. With the global RE supply shortage intensifying, the further increase in demand amplifies the positive impact of GPR on REE. Third, thanks to its unique physical and chemical properties, RE is widely used in clean technologies such as solar panels, electric vehicles and energy storage systems (Ding et al., 2024; Vivoda et al., 2025). In the post-pandemic era, the transition to green and clean energy has created new investment opportunities for RE mining (Li et al., 2023; Wang et al., 2025). Therefore, the importance of RE as a key low-carbon transition asset has become increasingly prominent (Zhang et al., 2025; Zhang and Jiang, 2025). In this context, countries have expanded their procurement and reserves of RE to avoid supply disruptions caused by high GPR, leading to a rising trend in REE (Ye et al., 2023; Wang et al., 2025).

During the period of 2022: M9-2024: M2, the positive impact of GPR on REE can be explained by the following three points. First, the outbreak of the Russia-Ukraine conflict has intensified global tensions, weakened the stability of the international environment and pushed the GPR to a historic high of 318.95 in March 2022 (Liu et al., 2023). To maintain military capabilities and strengthen national security, countries invest heavily in defense spending to enhance their military capabilities (Li et al., 2023). As crucial raw materials for advanced defense technologies and military products, the increased stockpiling of RE drives sustainable growth in demand (Islam, 2025). Second, the ongoing escalation of the Russia-Ukraine crisis and long-term unrest in the Middle East have further complicated the geopolitical situation and triggered a dilemma of crude oil supply shortages. With the global economic recovery, industrial production and transportation development have increased the demand for crude oil (Huang et al., 2025). The intensifying supply-demand conflict has caused a significant rise in international OP, leading the WTI price to reach \$95 per barrel on September 19, 2023. The rise in OP highlights the risk-hedging attribute of oil in turbulent environments, which motivates a large number of investors to pour funds into the crude oil futures market (Li et al., 2026). Due to the close cost correlation between extraction, refining, and processing of RE and oil, investors have also developed strong expectations for the rise in RE prices, which significantly boosts REE (Li et al., 2026). Third, the continuing intensification of the internal conflict in Myanmar causes a complete halt in local RE mining and forces closures along the China-Myanmar border. As Myanmar is a major global supplier of heavy RE concentrates, its production halt has led to a significant gap in the global supply of heavy RE. As a result, purchases of heavy RE concentrates from China by various governments have stimulated the growth of REE. Therefore, the above conclusions validate Hypothesis 2, which underscores that GPR can stimulate huge demand for RE from investors and increase strategic reserves, thereby exerting a positive impact on REE.

Figures 4 and 5 illustrate the bootstrap p-values and impact directions of REE on GPR, respectively. During the periods 2014: M4-2014: M7 and 2015: M3-2015: M11, there are causal relationships between REE and GPR at the 10% level. Two negative impacts of REE on GPR can be observed during these periods.

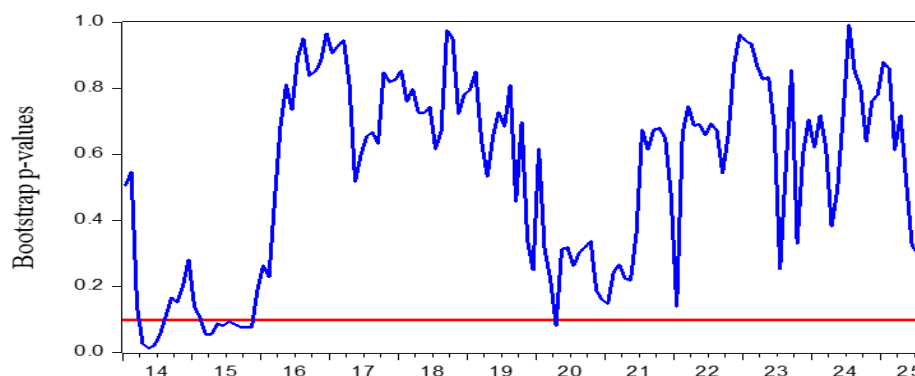
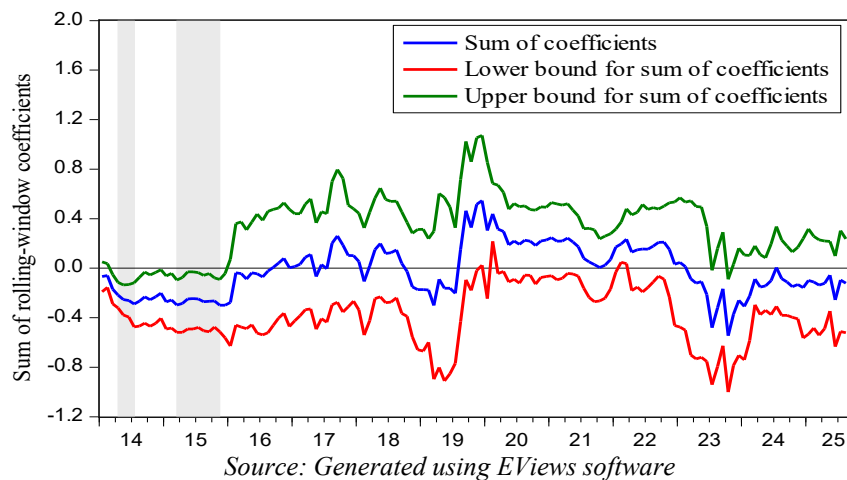


Figure 4. The p-values with no effect of REE on GPR.

Source: Generated using EViews software

Figure 5. The influence coefficient of REE on GPR.



In the time frame 2014: M4-2014: M7, under the dual influences of rising environmental protection costs and WTO trade disputes, REE shows a significant downward trend. On February 13, 2014, China's Ministry of Industry and Information Technology issues the "Promotion Plan for Cleaner Production Technology in the Rare Earth Industry". The policy aims to decrease pollutant emissions by improving the level of cleaner production in the RE sector. The implementation of this policy increases production costs for enterprises and reduces their operational profits, posing a significant barrier to the growth of REE. On March 26, 2014, the WTO rules that China's restrictions on REE violates trade rules (Xu et al., 2024; Kang et al., 2025). In response, China appeals to the WTO regarding the RE trade dispute on April 17, 2014. During this period, the escalation of trade friction prompts China to increase its strategic reserves of RE and significantly decrease export quotas. This intensifies western governments' criticism of China using RE as a trade weapon and deepens mutual distrust. Besides, international disputes over RE increase concerns in various countries about China being the sole supplier. As a result, western countries led by the U.S. accelerate import diversification and promote supply chain security strategies in an attempt to lower the heavy dependence on China's imports. These moves heighten international competition for RE and threaten the security of China's political environment. Therefore, the reduction of REE boosts the growth of GPR, which confirms the negative impact between the two variables.

Switching to the sub-sample period 2015: M3-2015: M6, REE experiences a significant growth. On May 1, 2015, the newly implemented tax reform reduces the cost burden on RE enterprises and stimulates the expansion of production scale (Mancheri et al., 2019). Meanwhile, the cancellation of export quotas and tariffs results in increasing China's RE supply (Mancheri et al., 2019). As a result, the sharp drop in RE prices triggers a purchasing frenzy for RE in various countries (Zhang et al., 2025). In addition, the surge in REE significantly hampers global GPR. First, the end of the RE trade dispute demonstrates China's good image of adhering to WTO rules, creating favorable conditions for easing tensions with the U.S., Japan and the European Union and improving multilateral trade relations. Second, the growth of REE has effectively reduced the risk of production halts caused by severe dependence on RE in sectors such as defense, new energy vehicles and high-tech industries due to supply disruptions, laying a foundation for ensuring corporate production. Moreover, a stable RE supply contributes to alleviating global concerns over supply interruptions and reducing geopolitical maneuvers triggered by resource competition. Third, the expansion of REE has led to a sharp drop in global prices, delaying the process of Western countries establishing a supply chain independent of China's RE. This forces them to rely more on China in the global RE supply chain and maintain cooperative trade relations, thereby reducing GPR triggered by direct confrontation.

Therefore, the above analysis confirms Hypothesis 3, which highlights that the growth of REE can foster a more peaceful international political environment.

To verify the robustness of the empirical results, this paper adopts an alternative proxy variable to replace GPR for robustness testing. Specifically, the Geopolitical Risk Threat Index (GPRT) is used as a proxy variable for GPR. At the same time, we log-transform the GPRT to prevent potential biases caused by heteroscedasticity.

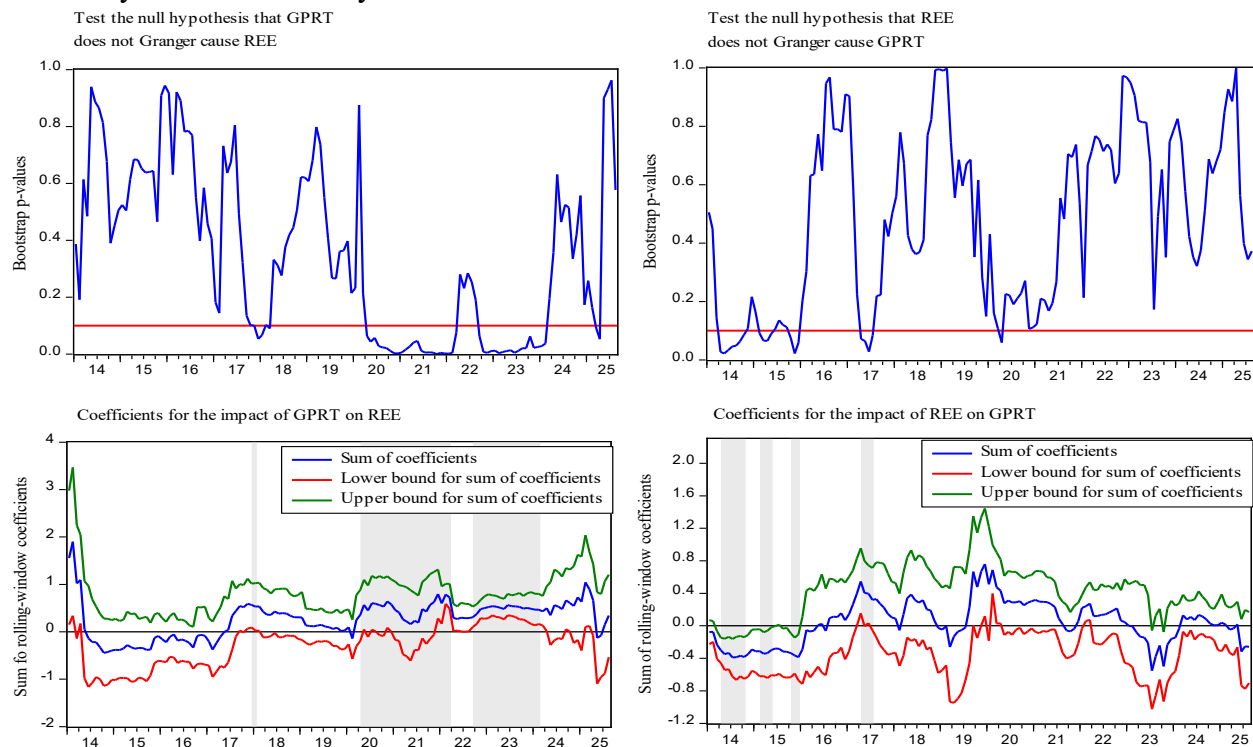


Figure 6. The results between GPRT and REE.

Source: Generated using EViews software

Figure 6 reports that GPRT exerts a significant promotion effect on REE during 2017: M12-2018: M1, 2020: M4-2022: M3 and 2022: M9-2024: M2. REE exhibits negative links to GPRT during 2014: M4-2014: M10, 2015: M2-2015: M5 and 2015: M10-2015: M12. Moreover, there is a favorable relationship from REE to GPRT during 2017: M4-2017: M7. These outcomes are largely consistent with Figures 3-6, confirming the robustness of the empirical findings in this paper.

3. Conclusions

In the context of the global transition to clean energy and a low-carbon economy, RE has become a central battlefield for resource competition and geopolitical rivalry among countries. Therefore, this paper examines the complex linkages and dynamic relationships between GPR and REE over time. To address the limitations of existing research that overlooks their bidirectional causal relationship, this study uses both full-sample and sub-sample methods. We find that the effects between GPR and RE vary across different time points. During the periods of 2020: M4-2022: M3 and 2022: M9-2024: M2, GPR produces a favorable shock to REE. The reason is that escalating geopolitical tensions raise global concerns about the vulnerability of RE supply chains and strengthen the strategic significance of RE in the defense and renewable energy industries. Therefore, the fervent rush to purchase and stockpile has created favorable conditions for expanding the sustainable export of China's RE. On the contrary, REE is negatively correlated with GPR. During 2014: M4-2014: M7, the reduction of REE intensifies international competition for RE and increases the complexity of the geopolitical environment. During 2015: M3-2015: M11, the stable and sustainable REE is conducive to improving

multilateral trade relations, delaying new RE supply chains construction and paving the way for geopolitical stability.

Based on the above research findings, this analysis presents some concrete and meaningful policy measures for governments and investors. First, the positive correlation between GPR and REE highlights the safe-haven value of RE during turbulent times. Thus, investors can dynamically adjust their investment portfolios and asset allocations according to changes in global GPR. In a volatile geopolitical environment, investors can view RE as a hedge to avoid significant losses caused by heightened GPR. In addition, this positive effect implies that GPR can predict future fluctuations of REE. To this end, governments should establish early warning systems for REE fluctuations and integrate GPR into monitoring systems, so as to avoid negative impacts on the RE market caused by geopolitical turmoil. Second, the negative effect of REE on GPR confirms the significant role of a stable REE in reducing geopolitical games and military conflicts triggered by resource competition. Therefore, China should assume its responsibility as the world's largest RE exporter, regulating RE exports under the premise of safeguarding national security to maintain the security of the global supply chain. Furthermore, China should vigorously promote the efficient utilization of the RE, minimizing pollution emissions and environmental damage caused by the mining and refining processes, thereby achieving sustainable use of RE. Third, various governments should encourage enterprises and research institutions to increase investment in RE technologies through tax incentives and financial subsidies, so as to enhance domestic mining and processing capabilities. Moreover, recovering RE from electronic products and industrial waste provides an energy-efficient and sustainable solution. Therefore, governments should increase investment in recycling technologies and alternative materials projects to achieve the sustainable use of RE. Fourth, against the backdrop of accelerating energy transition and climate governance, the demand for RE in various countries is expected to show a rapid growth trend. To this end, governments should strengthen the security of RE supply through diversifying imports channels, establishing strategic reserve plans and technological innovation cooperation. Furthermore, governments should actively expand international cooperation and diversify sources of RE imports by building open and collaborative trade partnerships, in order to reduce the risks caused by supply disruptions.

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EVALUATION OF THE CORRELATION BETWEEN TAX EVASION AND TRANSFER PRICING IN THE FRAMEWORK OF INTERNATIONAL TRANSACTIONS

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Abstract: *The increasing globalization of economic activity has intensified concerns regarding tax evasion and the use of transfer pricing strategies by multinational enterprises. This study aims to evaluate the relationship between tax evasion and transfer pricing within the framework of international transactions, with a particular focus on European Union member states. Given the difficulty of directly measuring these phenomena, the analysis employs proxy variables, using Foreign Direct Investment inflows as an indicator of multinational activity and potential profit shifting, and tax-related and institutional indicators as explanatory factors. The empirical investigation is based on a panel dataset covering European Union countries over the period 2012-2024. The model incorporates Corporate Income Tax rates, Gross Domestic Product, the Corruption Perceptions Index, and the Index of Economic Freedom, alongside a dummy variable distinguishing between low-tax and high-tax jurisdictions. Based on these variables two model specifications are estimated in order to assess the robustness of the relationship between corporate taxation and Foreign Direct Investment inflows: a baseline model including a tax regime dummy variable and an extended model incorporating economic size, proxied by Gross Domestic Product. The results suggest that multinational enterprises do not base their decisions solely on statutory tax rates, but rather consider a broader set of factors, including market size, institutional environment, and economic conditions. From the perspective of transfer pricing, the results suggest that firms may rely on profit-shifting strategies to mitigate tax differentials, thereby weakening the direct link between tax rates and observable investment flows.*

Key words: *tax evasion, tax avoidance, profit shifting, transfer pricing, corruption, multinational companies.*

JEL: F23, H25, H26, H32.

Introduction

The increasing integration of global markets has significantly transformed the landscape of international taxation, raising complex challenges for both policymakers and tax authorities. Multinational enterprises now operate across multiple jurisdictions, engaging in a wide range of cross-border transactions that create opportunities for strategic tax planning. Among the most debated issues in this context are tax evasion, tax avoidance, and the use of transfer pricing mechanisms, which directly influence the allocation of taxable income between countries.

Transfer pricing, defined as the pricing of transactions between related entities within the same corporate group, plays a central role in international business operations. According to the Organisation for Economic Co-operation and Development („OECD”), the arm’s length principle represents the internationally accepted standard for ensuring that such transactions reflect market conditions. However, in practice, the application of this principle is often limited and this creates opportunities for multinational firms to manipulate transfer prices in ways that shift profits to jurisdictions with lower tax burdens.

At the same time, tax evasion and tax avoidance have become increasingly difficult to distinguish in a globalized economy. While tax evasion involves illegal practices, tax avoidance refers to the use of legal mechanisms to minimize tax liabilities. Transfer pricing occupies a complex position between these two concepts, as it is both a legitimate business practice and a potential instrument for aggressive tax planning.

In response to these challenges, international initiatives such as the Base Erosion and Profit Shifting („BEPS”) project have sought to improve transparency and reduce the scope for tax base erosion. These efforts emphasize the need to align taxation with economic activity and value creation. Nevertheless, despite significant regulatory progress, empirical evidence suggests that multinational enterprises continue to exploit differences in tax regimes and institutional environments when making investment decisions.

The first part of the article consists in a literature review, where numerous studies have examined the implications of international transactions. Subsequently, the research methodology is analysed, where the database used is presented, as well as the descriptive statistics and the regression models. The econometric findings are further explained by their economic implications. The paper ends with conclusions, research limitations, and future research directions.

Literature review

The magnitude of corporate tax avoidance is difficult to assess in practice, largely due to limited transparency, as multinational enterprises do not fully disclose the specific tax planning strategies and mechanisms they employ (Alvarez-Martinez et al., 2022). Based on a study conducted by Neacsu and Feleaga (2017), following a significant reform of Romanian transfer pricing legislation, the authors found that a substantial majority of Romanian specialists (approximately 73%) believed that the new regulations would lead taxpayers to place greater emphasis on transfer pricing compliance. However, this conclusion was based on perceptions rather than empirical validation, as no subsequent analysis was conducted to confirm whether such behavioral changes actually occurred.

The issue of tax evasion has received considerable attention from researchers and policymakers. For this reason, data from 29 OECD countries covering the period 1990-2013 were used, and a panel approach was applied to estimate the results. In the first stage, an index for tax evasion was estimated, and in the second stage, the effects of tax evasion and tax revenue on economic stability were examined. The results show that as the tax rate increases, the probability of tax evasion also increases (Mehrrara and Farahani, 2016). According to Stoewhase (2002), it is presumed that high effective taxes inhibit foreign direct investment in actual activities, whereas a higher statutory tax rate discourages investment aimed at profit-shifting.

The decision to invest outside the country is driven by various factors, including market size and access to low-cost resources. In recent years, the presence of multinational companies in international trade has grown significantly. Based on the analysis conducted by Butnaru et al. (2016), it was found that multinational companies relocate their operations to jurisdictions with low tax rates, high levels of corruption, and low levels of economic freedom, where labor is cheap, thereby gaining operational and tax advantages. Consequently, transactions with affiliated parties and transfer pricing have come to be regarded as a powerful tool for financial fraud. Transactions with affiliated parties located in tax havens are one of the main factors contributing to investor confidence. For example, according to Neacsu and Feleaga (2016), 36% of companies listed on the Bucharest Stock Exchange have affiliates in tax havens.

Fatica and Gregori (2020) investigated the extent to which the largest and systemically important European multinational banks participate in profit shifting to reduce their tax liabilities. The authors concluded that, overall, 21% of profits are relocated. Moreover, profits reported in tax havens are estimated to be approximately 51% higher than they would be in the absence of tax-motivated profit shifting, indicating a substantial erosion of the tax base in high-tax jurisdictions.

Hugger et al. (2023) provide empirical evidence on the prevalence of low-taxed profits among multinational enterprises, reinforcing the argument that transfer pricing and profit shifting significantly affect the allocation of taxable income across jurisdictions. Using a four-year sample on the global activities of large multinational enterprises, the analysis shows that 12.7% are taxed at effective tax rates below 5% and a further 23.4% are taxed at effective tax rates between 5% and 15%.

Recent empirical contributions further highlight both the regulatory and practical dimensions of transfer pricing. While some studies emphasize the importance of international cooperation in resolving disputes (Lupu, 2023), others focus on the effectiveness of policy measures such as the BEPS initiative in limiting aggressive tax planning (Lupu, 2024). Moreover, Ignat and Tache (2023) demonstrate the existence of a positive relationship between the rigor of a country's transfer pricing regulatory framework and its progress in achieving sustainable development goals. Another investigation aims to demonstrate if transfer pricing legislation limits the profit shifting behaviour and concluded that transfer pricing rules significantly reduce shifting activities. Such regulatory frameworks may be socially desirable, notwithstanding the substantial administrative burden they impose on both firms and tax authorities (Lohse and Riedel, 2013).

According to Zilio (2017), cross-border differences in corporate income tax rates create incentives for multinational enterprises to manipulate the prices they use in intra-group transactions in order to shift profits to countries with more favorable tax regimes. Many European countries appear to be benefiting financially from this profit shifting by multinational companies, largely at Germany's expense (Huizinga and Laeven, 2006).

Methodology

The empirical study examines the relationship between Foreign Direct Investment ("FDI") inflows and Corporate Income Tax Rate ("CIT"), Gross Domestic Product ("GDP"), Corruption Perceptions Index ("CPI"), Index of Economic Freedom ("EFW"). The database covers the period 2012-2024 (2012 is the first year of public data for CPI and 2024 is the most recent year with complete data for all variables) and includes European Union ("EU") countries, obtained from publicly available sources.

The following table presents the selected variables used in the empirical research.

Table 1. Description of the variables

Variables	Definition	Source
Dependent variable		
FDI	FDI are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP.	World Bank
Independent variable		
CIT	CIT refers to total taxes (including direct taxes, indirect taxes and compulsory actual social contributions) as % of GDP.	European Commission
GDP	GDP is the total income earned through the production of goods and services in an economic territory during an accounting period. It can be measured in three different ways: using either the expenditure approach, the income approach, or the production approach. This indicator is expressed in current prices, meaning no adjustment has been made to account for price changes over time. This indicator is expressed in United States dollars.	World Bank
CPI	CPI ranks 180 countries and territories around the world according to perceived levels of public sector corruption, assigning a score on a scale from 0 (very corrupt) to 100 (very clean).	Transparency International
EFW	EFW covers 12 freedoms (from property rights to financial freedom) in 184 countries. If the EFW index is closed to 100 it means that the respective country enjoys the economic freedom.	The Heritage Foundation

Source: Author's own research

At the EU level, the study employs a multivariate panel data regression model, following the framework of Brooks (2008). Multivariate panel data regression was approached by Brooks in the general form as follows.

$$y_{it} = \alpha + \beta x_{it} + u_{it}, \text{ where:}$$

- y_{it} – dependent variable;
- x_{it} – independent variable;
- α – constant;
- u_{it} – time-varying random component;
- $i = 1, \dots, N$, and N is the size of the sample of countries;
- $t = 1, \dots, T$, and T is the size of the time series.

The modelling of the impact of selected indicators on FDI is carried out in the form of a multiple regression with panel data where FDI is the dependent variable and selected indicators (CIT, GDP, CPI, EFW) are the independent variables. The data is processed using Microsoft Excel and the regression analysis is conducted using EViews 10.

Results and discussions

Figure 1 shows the evolution of CIT rates in EU countries both the beginning and the end of the analysed period, namely 2012-2024. The CIT rates of EU countries are presented in ascending order for 2024 in order to distinguish between jurisdictions with the lowest and highest tax levels.

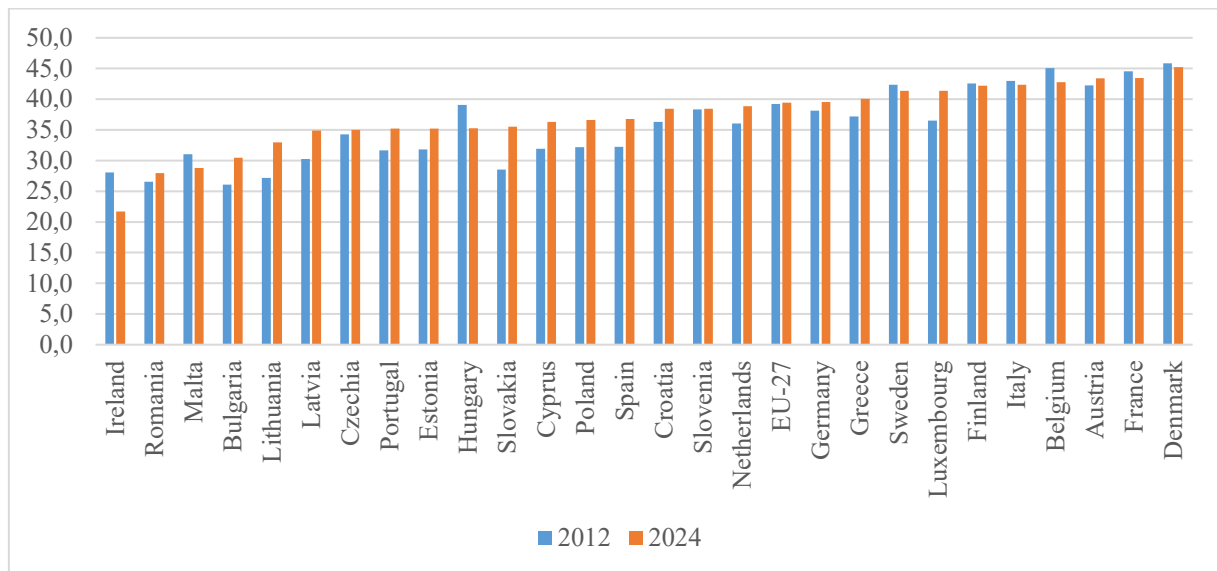


Figure 1. Evolution of CIT in EU countries in 2012 vs. 2024

Source: Author's own research

As it can be observed in Figure 1, in the most recent year, Ireland, Romania, Malta, Bulgaria, Lithuania and Latvia recorded lowest CIT rates, while Denmark, France, Austria, Belgium, Italy and Finland recorded highest CIT rates. In most countries, there is a slight increase in CIT rates in 2024 compared to 2012. This reflects: increased fiscal pressures (post-crisis, pandemic), the need for fiscal consolidation, and efforts to align with international initiatives (e.g., the global minimum tax).

The empirical analysis is based on a panel dataset covering EU member states over the period 2012–2024. FDI inflows, expressed as a percentage of GDP, are used as a proxy for multinational activity and potential profit shifting. The model includes CIT rates as the main explanatory variable, along with economic size such as GDP and institutional factors such as the CPI and the EFW.

To capture potential heterogeneity across countries, a dummy variable was introduced to distinguish between low-tax and high-tax jurisdictions, based on the median CIT rate within the EU. The dummy variable is named High-Tax („HT”) and it takes value 1 if the CIT rate is higher than EU median and takes value 0 otherwise.

Based on the variables included in the empirical analysis, Table 2 presents the descriptive statistics of those variables.

Table 2. Summary statistics of the variables

Variables	Mean	Median	Maximum	Minimum	Skew.	Kurt.
FDI	12.70	2.93	452.22	-391.56	2.71	27.81
CIT	36.37	35.50	49.04	19.44	-0.30	2.70
CPI	63.62	60.00	92.00	36.00	0.25	1.90
EFW	69.70	69.50	82.60	53.20	-0.24	2.66
GDP	26.12	26.20	29.18	22.99	0.11	2.25

Source: Author's own research

The dependent variable, FDI (expressed as a percentage of GDP), exhibits a high degree of dispersion, as indicated by the substantial difference between the mean (12.70) and the median (2.93). This suggests the presence of extreme values, which is further confirmed by the wide range between the minimum (-391.56) and maximum (452.22). The CIT rates displays relatively low variability, with values ranging between 19.44 and 49.04 and a mean of 36.37. The CPI shows moderate dispersion, with a mean value of 63.62 and a range between 36.00 and 92.00. Similarly, the EFW exhibits limited variability, with a mean of 69.70 and values ranging from 53.20 to 82.60. Finally, GDP (expressed in logarithmic form) presents a high level of stability, with a narrow range between 22.99 and 29.18 and a mean of 26.12. Overall, the descriptive statistics indicate that while institutional and fiscal variables are relatively stable across countries, FDI exhibits significant variability and the presence of extreme values.

Following past studies conducted by other authors (Stoewhase, 2002; Butnaru et al., 2016), two model specifications are estimated in order to assess the robustness of the relationship between corporate taxation and FDI: a baseline model including a tax regime dummy variable and an extended model incorporating economic size, proxied by GDP. The empirical findings obtained from the panel data analysis is conducted on 27 EU countries over the period 2012–2024.

Table 3. Data panel regression coefficients

Dependent variable: FDI		
Variables	Model 1	Model 2
CIT	-4.45*	-2.63*
CPI	1.41*	1.47*
EFW	-2.75*	-3.24*
HT (dummy)	-53.96**	
GDP		-10.97*
C	278.30*	527.14*
R-squared	6.07%	9.44%
F-statistic	5.59	9.01
Prob(F-statistic)	0.00	0.00
Observations	351	351
Countries	27	27

Source: Author's own research

*Notes: * and ** denotes significant level at 1% and at 5%.*

The first model examines the impact of CIT rates, institutional variables, and a dummy variable capturing high-tax jurisdictions on FDI inflows. The results indicate a negative and statistically significant relationship between CIT rates and FDI (coefficient = -4.45, $p < 0.01$), suggesting that higher statutory tax rates discourage foreign investment. This finding is consistent with the traditional view that multinational enterprises allocate capital in response to tax differentials across jurisdictions. Institutional quality, proxied by CPI rates, exhibits a positive and significant effect (coefficient = 1.41, $p < 0.01$), indicating that less corrupt and more transparent environments are more attractive to foreign investors. This result aligns with the broader literature emphasizing the role of governance in

investment decisions. EFW displays a negative and significant coefficient (coefficient = -2.75, $p < 0.01$). Although counterintuitive, the negative coefficient may reflect the fact that more economically advanced countries rely less on foreign direct investment relative to their economic size. The dummy variable capturing high-tax countries is negative and statistically significant (coefficient = -53.96, $p < 0.05$), indicating that countries with higher tax burdens tend to attract significantly lower levels of FDI inflows. This supports the theory that tax regime differences across countries influence investment allocation. Overall, the baseline model suggests that both tax policy and institutional quality play a role in shaping FDI patterns, while also highlighting structural differences between high-tax and low-tax jurisdictions.

The second model replaces the dummy variable with a continuous measure of economic size, namely the logarithm of GDP, in order to capture structural economic differences more precisely. The results confirm the negative and statistically significant impact of CIT rates on FDI (coefficient = -2.63, $p < 0.01$), although the magnitude of the effect is reduced compared to the baseline model. This suggests that part of the tax effect observed previously may be associated with underlying economic characteristics. Institutional quality (CPI) remains positive and significant (coefficient = 1.47, $p < 0.01$), reinforcing the robustness of this variable as a key determinant of foreign investment. The coefficient of EFW remains negative and statistically significant (coefficient = -3.24, $p < 0.01$), confirming the pattern observed in the baseline model. A particularly noteworthy result is the negative and highly significant coefficient of GDP (coefficient = -10.97, $p < 0.01$). This suggests that larger economies tend to attract lower levels of FDI relative to their size. This finding can be explained by the fact that smaller economies often rely more heavily on foreign capital and may offer more attractive conditions for multinational enterprises. Importantly, once GDP is introduced, the need for a categorical distinction between high-tax and low-tax countries diminishes, indicating that economic fundamentals provide a more accurate explanation of FDI patterns than simple tax-based classifications.

Finally, the results suggest that multinational enterprises do not base their decisions solely on statutory tax rates, but rather consider a broader set of factors, including market size, institutional environment, and economic conditions. This finding is particularly relevant in the context of transfer pricing, as it indicates that multinational enterprises may rely on alternative mechanisms to optimize their tax burden beyond simple relocation to low-tax jurisdictions.

In light of these considerations, the present study contributes to the existing literature by exploring the relationship between transfer pricing (proxied by FDI flows) and tax evasion (proxied by tax revenue indicators) across countries. By adopting a cross-country perspective and relying on publicly available data, the study aims to provide empirical insights into the extent to which transfer pricing practices are associated with variations in tax collection outcomes. This approach complements existing firm-level analyses (Stoewhase, 2002; Butnaru et al., 2016) and offers a broader understanding of the systemic implications of profit shifting in the global economy.

Conclusions

This study examined the relationship between corporate taxation and FDI inflows within the EU, with a particular focus on the role of tax differentials and their potential link to profit shifting and transfer pricing practices. Using panel data for 27 EU countries over the period 2012–2024, two complementary model specifications were employed in order to capture both fiscal and structural determinants of investment.

The empirical results provide consistent evidence that CIT rates have a negative and statistically significant effect on FDI inflows, confirming that taxation remains an important factor in multinational investment decisions. This finding supports the conventional view in the literature that higher statutory tax burdens reduce the attractiveness of a jurisdiction. In addition, the results highlight the significant role of institutional quality, as measured by the CPI. Countries with more

transparent and stable governance frameworks tend to attract higher levels of foreign investment, reinforcing the importance of non-fiscal factors in shaping investment decisions.

However, the analysis also reveals that the impact of taxation is not independent of broader economic and institutional conditions. When economic size, proxied by GDP, is introduced into the model, the magnitude of the tax effect decreases, suggesting that part of the observed relationship between taxation and FDI is mediated by structural characteristics of the host economy. This indicates that multinational enterprises consider a wider set of determinants beyond fiscal variables when allocating investment.

From the perspective of the research topic, these results carry important implications for the analysis of tax evasion and transfer pricing. The fact that statutory tax rates do not fully explain investment patterns suggests that multinational enterprises may rely on alternative mechanisms, such as transfer pricing strategies, to optimize their tax burden without necessarily relocating real economic activity. In this context, profit shifting may weaken the direct relationship between tax rates and observable investment flows.

The study is subject to several limitations. First, FDI expressed as a percentage of GDP represents an indirect proxy and may not fully capture the complexity of multinational activity. Second, the relatively low explanatory power of the models indicates that additional variables could further improve the analysis. Also, the study relies on publicly available data from international sources. However, inconsistencies in data reporting across countries and years may affect the accuracy and completeness of the analysis.

Future research could extend the analysis by incorporating firm-level data that activate in a certain industry. (e.g., IT, auto, construction, agriculture). A factor that is significant for the multinationals that activate in a certain industry may be irrelevant for the multinationals that activate in a different industry.

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DIGITALIZATION INDICATORS AND THE STRUCTURAL TRANSFORMATION OF THE BANKING SECTOR: EVIDENCE FROM THE EUROPEAN UNION

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Abstract: *This paper investigates whether selected digitalization indicators reflect the structural transformation of the banking sector in the European Union. The analysis is based on four complementary dimensions: the share of individuals using internet banking, the number of secure internet servers, the Digital Economy and Society Index (DESI), and the cybersecurity index. Methodologically, the study relies on a comparative longitudinal approach using country-level evidence for EU member states over partially overlapping periods determined by data availability. The findings show that digital banking transformation in the EU is strong, cumulative, and structurally relevant, but uneven across member states. Northern and Western countries display mature digital banking ecosystems, characterized by widespread online banking adoption, robust digital infrastructures, higher digital readiness, and stronger cybersecurity capabilities. By contrast, several Southern and Eastern member states continue to face persistent structural barriers linked to weaker digital infrastructure, lower digital skills, reduced trust in online services, and slower institutional adaptation. The paper argues that banking digitalization should be interpreted not only as technological modernization, but also as a broader restructuring of customer interaction, service delivery, operational models, and risk management. The study concludes that digital convergence in EU banking remains incomplete and requires coordinated action in infrastructure, digital literacy, financial education, and cyber resilience.*

Key words: digitalization, banking sector, online banking, DESI, cybersecurity, European Union

JEL: G21, O33, O52, C23

Introduction

Digitalization has become one of the strongest forces reshaping the banking sector in the European Union. What initially appeared as a gradual move toward electronic payments, card-based services, and internet banking has evolved into a broader structural transformation affecting customer interaction, service delivery, operational processes, data governance, and risk management. In this broader sense, digitalization is no longer limited to the adoption of isolated technologies, but represents a reconfiguration of how banks create value, organize internal functions, and compete in increasingly data-driven markets (Vial, 2019; Verhoef et al., 2021).

The relevance of this topic is amplified by the growing role of digital finance in economic modernization, financial inclusion, and institutional resilience. Recent studies show that digital transformation in finance is associated with operational efficiency gains, wider access to services, and changes in organizational capabilities, but also with higher exposure to cyber risk, regulatory challenges, and new inequalities in adoption (Mavlutova et al., 2023; Bueno et al., 2024; Wang et al., 2024). In banking, digital transformation increasingly overlaps with broader FinTech-driven change and with the capacity of institutions to redesign products, processes, and customer channels in line with the logic of Industry 4.0 (Gherțescu et al., 2024).

Within the European Union, this transformation remains markedly uneven. Although digital policy has advanced under a common European framework, national performances continue to differ substantially in terms of infrastructure, digital skills, business digitalization, and public service

readiness (Liu, 2022; Paraschiv et al., 2024). These asymmetries are reflected in the banking sector as well, where some member states have already reached mature digital ecosystems, while others remain constrained by limited infrastructure, lower digital trust, and slower institutional adaptation. Online banking adoption, in particular, continues to reveal large cross-country differences shaped by governance, technological progress, and crisis-related adjustment processes (Grigorescu et al., 2023; Iuga, 2025).

Starting from this context, the present paper examines the structural transformation of the banking sector in the European Union through four complementary indicators: individuals using the internet for online banking, secure internet servers, the Digital Economy and Society Index (DESI), and the cybersecurity index. Together, these variables capture the demand-side use of digital financial services, the robustness of digital infrastructure, the national level of digital readiness, and the security environment that sustains digital finance. Their combined interpretation makes it possible to move beyond narrow descriptions of technological adoption and toward a broader understanding of how banking structures evolve under digital pressure.

The main objective of the paper is to assess whether these indicators provide consistent evidence of a structural shift in EU banking and to identify the extent to which this shift differs across member states. Four working hypotheses guide the analysis. First, a higher share of internet banking users reflects a more advanced structural transformation of banking services. Second, stronger secure digital infrastructure supports the expansion of digital banking. Third, better national digital readiness, captured by DESI, facilitates banking transformation. Fourth, higher cybersecurity maturity makes this transformation more sustainable by reinforcing trust and resilience. The contribution of the paper lies in integrating these dimensions into a single analytical framework focused on the European Union and in interpreting banking digitalization as a cumulative structural process rather than as a simple technological upgrade.

Literature review

The literature on digital transformation increasingly emphasizes that digital change should be understood as a systemic process rather than as the simple adoption of new technologies. Vial (2019) defines digital transformation as a process through which digital technologies trigger significant changes in value creation, organizational arrangements, and strategic responses. Verhoef et al. (2021) extend this view by showing that digital transformation alters customer relationships, competitive logic, firm capabilities, and business models. These conceptual contributions are highly relevant to banking because they explain why digitalization affects not only channels of interaction, but also the structural organization of financial intermediation.

A second stream of research focuses more directly on the banking sector and shows that digitalization is linked to operational efficiency, financial inclusion, and strategic repositioning. Mavlutova et al. (2023) argue that digital transformation can support sustainable development in the financial sector by improving inclusion and operational effectiveness. Bueno et al. (2024) likewise demonstrate that digitization in banking is frequently associated with lower transaction costs, process optimization, and new research directions connected to platformization and service redesign. In the same area, Gherțescu et al. (2024) show that the literature on bank efficiency increasingly intersects with digital transformation, FinTech, and Industry 4.0 topics, indicating a growing shift in how banking performance is framed in recent scholarship.

Another important strand examines online banking adoption and digital convergence across countries. Liu (2022) shows that European digital policy outcomes remain heterogeneous even within a common institutional framework, while Paraschiv et al. (2024) confirm that DESI-related dimensions remain strongly associated with broader national progress in digital transformation. At the level of banking behavior, Grigorescu et al. (2023) identify convergence tendencies in e-banking across EU countries, but also persistent differences in adoption patterns. Complementing this perspective, Iuga (2025) highlights the role of governance and technological progress in explaining internet banking adoption

across major crisis periods, confirming that digital banking expansion depends on more than the simple availability of technology.

A fourth stream of literature emphasizes the role of cybersecurity and systemic resilience in digital finance. Wang et al. (2024) argue that data privacy and cybersecurity are central challenges in the digital transformation of banking, especially in highly connected financial systems. Yudaruddin et al. (2023) further show that financial technology can influence bank stability, which suggests that digital progress should not be assessed only through adoption or efficiency, but also through the resilience of the environment in which innovation is embedded. Xu et al. (2025) similarly conclude that FinTech increasingly affects bank performance through multiple channels, including efficiency, innovation, and competitive adjustment. Although the literature is expanding rapidly, fewer studies combine usage, infrastructure, digital readiness, and cybersecurity in a single EU-wide analytical narrative. This paper addresses that gap.

Methodology

The paper relies on a comparative longitudinal research design based on secondary country-level evidence for the member states of the European Union. The analysis is developed around four indicators that capture complementary dimensions of digitalization: individuals using the internet for online banking services, secure internet servers per million inhabitants, the Digital Economy and Society Index (DESI), and the cybersecurity index. The periods covered differ according to data availability: 2013-2024 for online banking use, 2010-2024 for secure internet servers, 2017-2022 for DESI, and 2014-2023 for cybersecurity maturity. This structure allows the paper to capture both demand-side and supply-side aspects of banking digitalization, while also accounting for the broader institutional and security environment in which digital finance evolves.

Methodologically, the study does not claim causal identification. The available evidence is descriptive-comparative and is interpreted through trend analysis, leader-laggard comparisons, regional clustering, and cross-indicator synthesis. The approach is therefore appropriate for identifying the structural direction of change and for highlighting persistent asymmetries between EU member states. The analysis is guided by the idea that digital transformation in banking can be assessed through a cumulative interpretation of four interconnected layers: customer adoption, infrastructure, national digital readiness, and cybersecurity resilience. In this sense, the paper uses the selected indicators as proxies of structural transformation rather than as isolated descriptive statistics. The interpretation is also shaped by the institutional context of European digital monitoring. DESI remains a core reference point for the period up to 2022, while for later years the shift toward the Digital Decade framework signals a methodological transition in how digital progress is monitored at EU level. A limitation of the study is that the analysis is not based on panel econometric estimation and therefore cannot measure the magnitude of causal effects among variables. However, the comparative evidence remains highly relevant for identifying common trends, persistent divergences, and the broader logic through which digitalization is transforming the banking sector across the European Union.

Results and discussions

Individuals using the internet for online banking services

The first dimension analyzed concerns the share of individuals using the internet for online banking services. This indicator captures the extent to which digital delivery channels have become integrated into ordinary banking behavior and therefore provides a direct signal of structural transformation on the demand side. Between 2013 and 2024, the indicator registered a positive evolution in all EU member states, but the pace and the final levels differed considerably across regions. The data reveal a persistent contrast between the digitally mature systems of Northern and Western Europe and the less advanced systems of Southern and Eastern Europe.

The Nordic and Western countries remain constant leaders, confirming a very high level of digital banking maturity. Denmark, Finland, and Sweden all exceeded the 90% threshold, with Denmark

reaching 97.8% in 2024. Finland surpassed 93%, while Estonia and the Netherlands also recorded values above 90%, which indicates an almost complete integration of digital banking services into everyday financial activity. Luxembourg, Belgium, and Austria maintained high levels as well, generally ranging between 70% and 85%, which suggests a stable and consolidated digital ecosystem. These results point to a model of banking in which online access is no longer an auxiliary channel, but the dominant interface between clients and institutions.

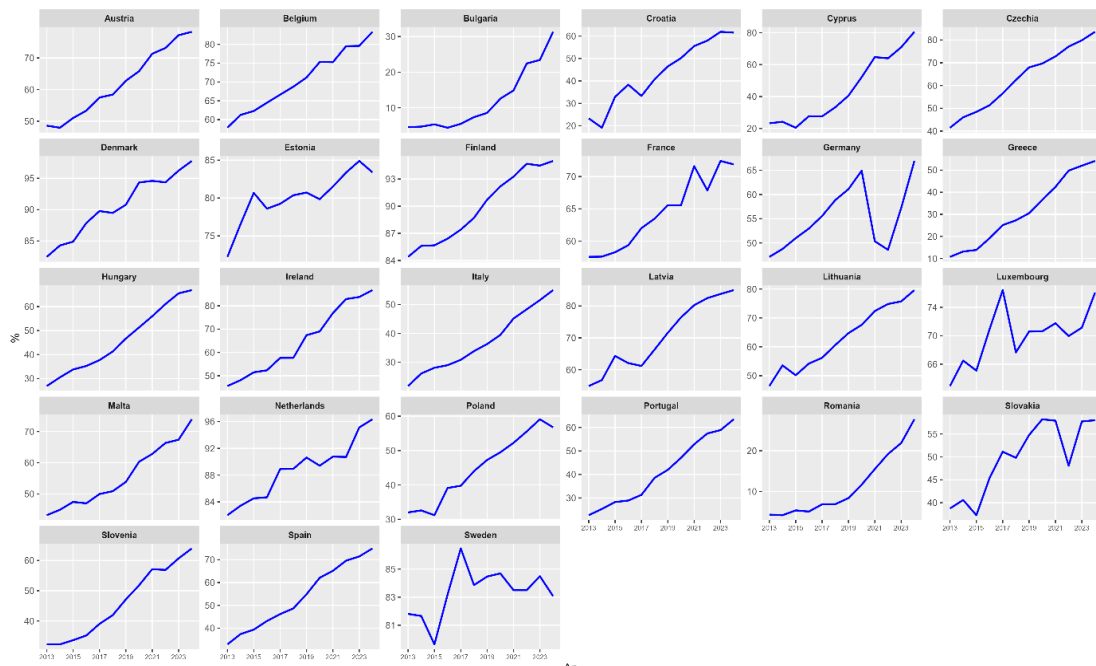


Figure 1. Evolution of the share of individuals using the internet for online banking services in EU member states (2013-2024)

Source: author's own processing based on Eurostat data

Central and Eastern Europe started from lower levels but recorded significant recovery. Lithuania increased from 46% in 2013 to 79% in 2024, while Latvia advanced from 55% to 84%, confirming the dynamic position of the Baltic states in the rapid adoption of digital banking. Poland and Hungary also recorded steady increases and exceeded the 60% threshold in recent years. Nevertheless, Romania and Bulgaria remain far below the EU average, with values of 27.7% and 31.3%, respectively, in 2024. Both countries are more than 40 percentage points below the EU average of 71.7%, which suggests that substantial structural barriers continue to affect digital adoption. These barriers are likely linked to weaker digital infrastructure, lower levels of financial and digital literacy, and reduced trust in online banking services.

Southern Europe displays an intermediate profile, with visible progress especially after 2020. Spain increased from 38% to above 70%, Portugal from 22% to around 60%, and Italy from 28% to 52%. Greece, although starting from extremely low values below 10% in 2013, reached 54.1% in 2024. This pattern suggests that the pandemic acted as an accelerator, forcing a faster transition toward digital banking solutions in countries where face-to-face intermediation had previously remained relatively strong. From a temporal perspective, two key moments are visible: 2015-2017, when acceleration became clear in the Nordic and Baltic states, and the post-2020 period, when Southern and Eastern Europe moved more decisively toward digital service adoption. The comparative distribution in 2024 highlights strong polarization within the European Union. Denmark exceeds the EU average by more than 26 percentage points, whereas Romania and Bulgaria remain more than 40

percentage points below it. Greece occupies an intermediate position, with 54.1%, reflecting meaningful recovery but not full convergence. Overall, the indicator shows that banking digitalization has become a central pillar of financial intermediation in the EU, but also that the process still unfolds at different speeds. In structural terms, the Union continues to function with a two-speed digital banking system: a Northern-Western group close to saturation and a Southern-Eastern group still engaged in a slower and uneven catching-up process.

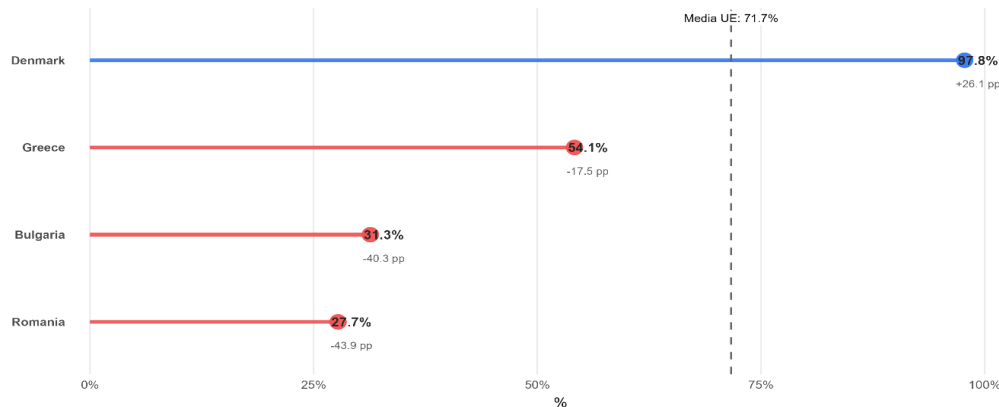


Figure 2. Comparative analysis of the highest and lowest levels of online banking use in the European Union (2024)

Source: author's own processing based on Eurostat data

Secure internet servers

The second indicator concerns secure internet servers, which represent one of the core pillars of digital infrastructure. Online banking, mobile banking, remote onboarding, and digital payments all depend on a secure online environment capable of protecting transactions and user data. For this reason, the number of secure internet servers per population can be interpreted as an indirect but highly relevant measure of the infrastructure that supports digital banking. A larger number of secure servers suggests a stronger technical environment for protected online interaction, which in turn may strengthen user trust and facilitate the expansion of digital financial services.

Between 2010 and 2024, all EU member states recorded growth in this indicator, but the scale of the increase differed widely. Germany stands out very clearly, with more than 12.7 million secure internet servers per million inhabitants in 2024, compared with an EU average of approximately 1.24 million. This result highlights not only Germany's economic and technological strength, but also the fact that digital banking expansion is supported by a very robust security infrastructure. In this setting, the

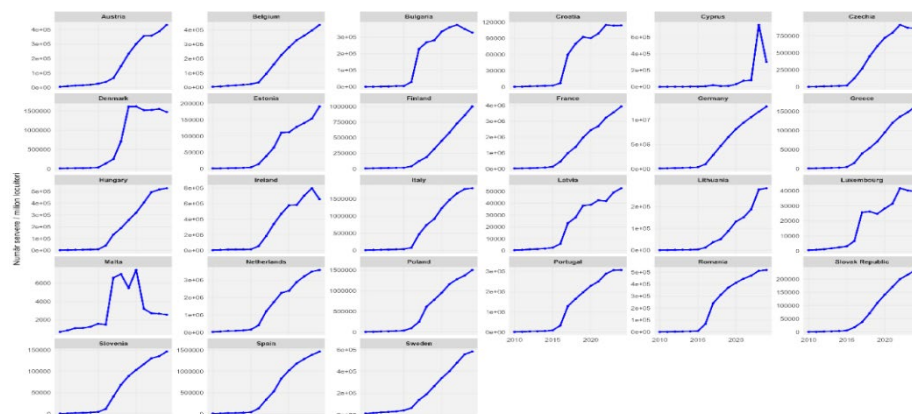


Figure 3. Evolution of secure internet servers per one million inhabitants in EU member states (2010-2024)

Source: author's own processing based on World Bank data

country functions as a hub of digital trust, where secure connectivity and data protection provide favorable conditions for the expansion of online banking services.

At the opposite end of the distribution, small or peripheral states such as Malta, Latvia, and Luxembourg record much lower values. The supplied results indicate values of 2,564 servers for Malta, 52,659 for Latvia, and 39,563 for Luxembourg. In structural terms, these lower values may limit the scale and speed of digital banking expansion, since insufficient security infrastructure can discourage both institutions and users. In Luxembourg, however, the interpretation must remain cautious because the structure of the financial sector and the concentration or externalization of digital services may influence the indicator differently than in larger countries.

The period 2015-2020 marks a particularly visible acceleration in all countries, driven by tighter cybersecurity requirements, the expansion of e-commerce, and the increased use of online banking services. After 2020, the pandemic reinforced this movement because digital delivery became, in many situations, the only practical option. Countries such as Romania, Poland, and Lithuania recovered part of the gap more rapidly, reaching several hundred thousand secure servers and thereby creating more favorable conditions for faster digital banking adoption. Based on the supplied evidence, three broad categories can be distinguished: digital leaders such as Germany, France, the Netherlands, Poland, and Spain; a medium-development group including Italy, Romania, the Czech Republic, and Portugal; and a lower-level group including Malta, Latvia, and Luxembourg.

The indicator confirms that digital banking depends not only on customer demand, but also on the quality and depth of technical infrastructure. A stronger security architecture supports innovation, improves confidence, and enables banks to provide more advanced services. At the same time, the persistence of major asymmetries across countries shows that digital convergence within the EU banking sector is still incomplete and continues to depend on unequal national investments in infrastructure and cyber protection.

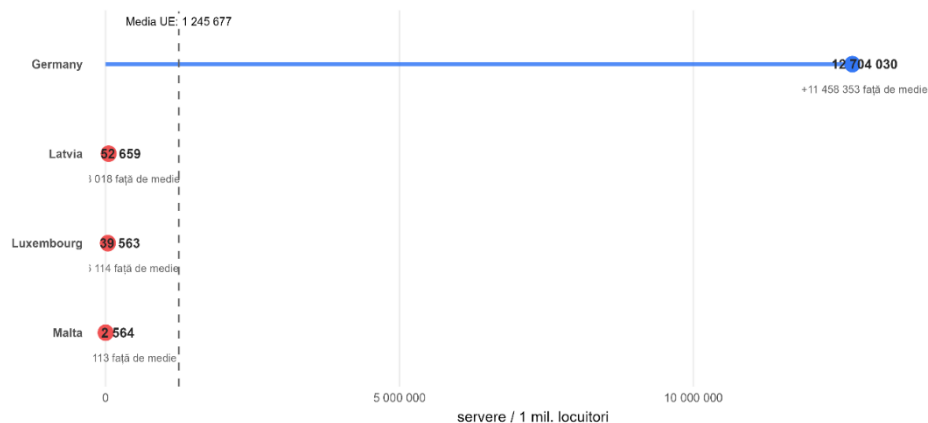


Figure 4. Comparative analysis of secure internet servers reported to population in EU member states with extreme levels (2024)

Source: author's own processing based on World Bank data

Digital Economy and Society Index (DESI)

The third dimension is represented by DESI, which provides a synthetic picture of digital development in EU member states and is therefore essential for understanding the broader environment in which banking digitalization takes place. Up to 2022, DESI was structured around four analytical components: human capital, connectivity, integration of digital technology, and digital public services. From 2023 onward, the classic DESI format was integrated into the Digital Decade monitoring architecture, which preserves analytical continuity but changes the reporting structure.

This methodological transition is relevant for banking studies because it affects the comparability of long-run digital readiness measures.

The supplied results show that the total DESI index followed an upward trajectory in all member states between 2017 and 2022, although at different speeds. The Nordic countries, namely Denmark, Finland, and Sweden, recorded the highest values and exceeded 65 points in 2022. These performances are associated with strong digital infrastructure, a high level of digital skills, sustained investments in innovation, and broad integration of technology into strategic sectors. The Netherlands and Ireland also positioned themselves at an advanced level, confirming structural convergence with the traditional digital leaders. In Western Europe, progress was positive but more moderate: Germany, France, Austria, and Belgium reached values in the range of 50 to 53 points. Central and Eastern Europe displays a mixed but generally improving pattern. Estonia and Lithuania exceeded 50 points and approached the values of several Western states, while the Czech Republic followed a similar path. Poland, Slovakia, and Hungary remained in the interval of 40 to 44 points. Romania and Bulgaria stayed below 40 points, although with a steady growth rate, which suggests a gradual but incomplete narrowing of the digital gap. Southern Europe also evolved unevenly. Spain stands out through a rapid advance beyond 60 points in 2022, Italy approached 50 points, Portugal exceeded 50, while Greece, Cyprus, and Croatia continued to improve from lower absolute levels.

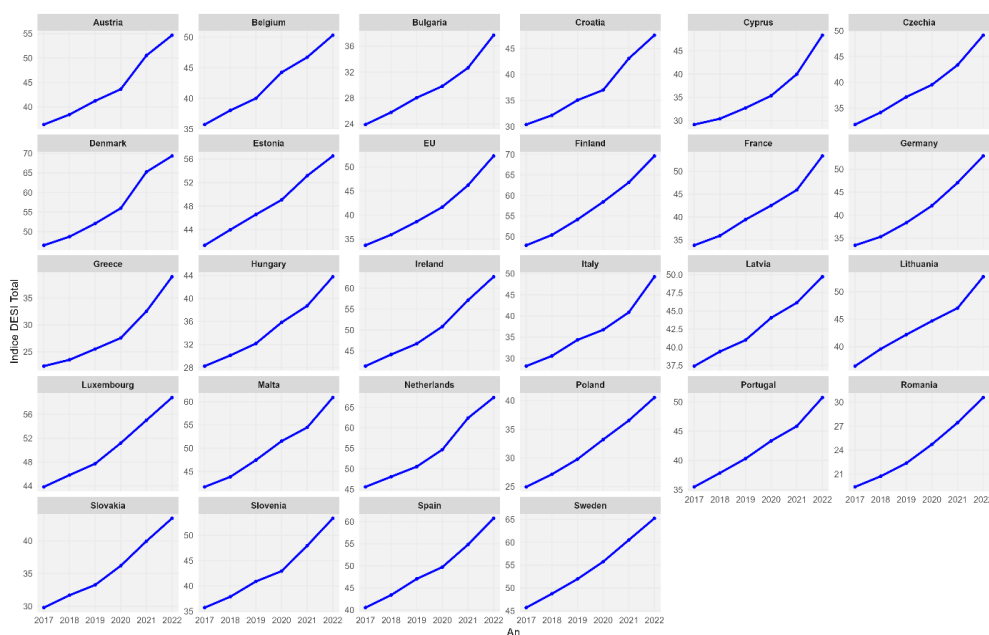


Figure 5. Evolution of the total DESI score in EU member states (2017-2022)

Source: author's own processing based on European Commission DESI data

The comparative pattern reveals two broad clusters: a group of states characterized by high digital maturity, relatively stable values, and structural convergence, and another group still in a recovery stage, where progress is visible but the gap persists. For the banking sector, this result is especially important because it shows that digital transformation is embedded in a wider national context. Where digital skills are stronger, connectivity is better, business digitalization is deeper, and public services are more digitalized, banks are more likely to benefit from a supportive environment for structural transformation. DESI therefore works as a contextual indicator of the national ecosystem within which digital banking develops.

Cybersecurity index

The fourth dimension concerns the cybersecurity index, which reflects the maturity of national systems of digital protection and the capacity of institutions to respond to cyber threats. In banking, this dimension is fundamental because the expansion of digital channels increases exposure to cyber risk and makes trust inseparable from security preparedness. The period 2014-2023 indicates accelerated convergence across the EU, supported by the harmonization of the regulatory framework, the strengthening of national cybersecurity strategies, and growing investments in critical infrastructures.

The time series suggest that during 2014-2016 the values of the index were moderate, generally ranging between 40 and 70 points in most countries. Between 2017 and 2020, however, the indicator increased sharply, with some states advancing by 20 to 30 points in a short interval. This phase can be interpreted as a period of accelerated institutional and technological adjustment. After 2020, the curves tend to flatten, and in many cases the values stabilize between 85 and 95 points. This plateau does not indicate stagnation, but rather a shift from rapid capacity-building toward consolidation, optimization, and the adoption of more sophisticated technologies.

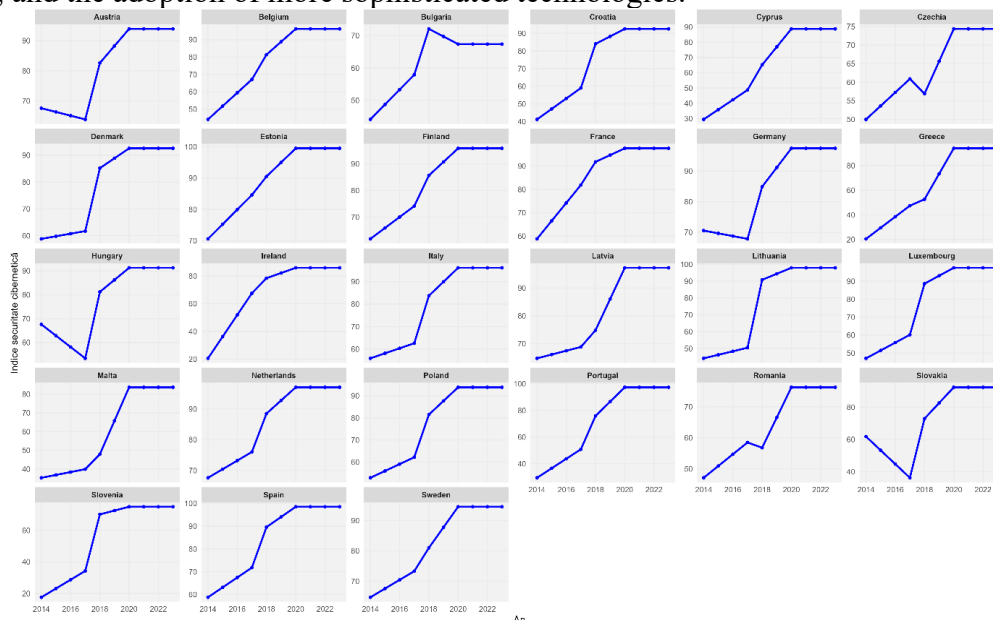


Figure 6. Evolution of the cybersecurity index in EU member states (2014-2023)

Source: author's own processing based on cybersecurity monitoring data

The best-performing countries include Estonia, Finland, Portugal, and Spain, each reaching 100 points in the supplied data. France and Germany also maintain high values, generally between 90 and 95 points, although their growth slows after 2020 as their systems approach maturity. At the lower end of the distribution, Romania, Bulgaria, Croatia, and Greece remain below the EU leaders, despite recording visible improvements. This confirms the persistence of a structural asymmetry: even when late adopters improve rapidly in absolute terms, the relative distance from the most advanced digital systems often remains significant. The results indicate three broad phases in the evolution of cybersecurity across the EU: a stage of moderate values and high variation during 2014-2016; a stage of accelerated growth and statistical convergence during 2017-2020; and a stage of plateauing and maturation during 2021-2023. The supplied evidence also reports an average annual growth rate for the EU of around 5.8% between 2014 and 2020, followed by a rate below 2% after 2020, which reinforces the interpretation of saturation. At the same time, the persistence of lower scores in South-Eastern Europe suggests that financial resources, institutional capacity, and human capital continue to shape the pace of cybersecurity convergence.

From the perspective of banking transformation, the cybersecurity index is particularly important because it connects digitalization with resilience. A banking system may digitalize rapidly, but if cyber protection remains weak, that progress becomes more fragile and less sustainable. The findings therefore suggest that structural transformation in banking is strongest where customer adoption, infrastructure, digital readiness, and cybersecurity mature together. Taken as a whole, the four indicators confirm that digitalization in EU banking is not a marginal or purely technical process, but a broader structural reconfiguration of how financial services are produced, delivered, and secured.

Conclusions

The paper examined whether selected digitalization indicators capture the structural transformation of the banking sector in the European Union. The answer is affirmative. The increasing use of online banking, the strengthening of secure digital infrastructure, the upward evolution of DESI, and the improvement of cybersecurity maturity all indicate that banking in the EU is moving toward a more digital, more remote, and more data-driven model of intermediation. At the same time, the results clearly show that this transformation remains uneven across member states and continues to be shaped by significant structural differences.

From a policy perspective, the findings suggest that digital convergence in banking cannot be achieved through financial-sector measures alone. It requires coordinated efforts in digital infrastructure, digital skills, financial education, cybersecurity capacity, and institutional support for innovation. The evidence also shows that trust is a decisive factor. Even where technical infrastructure improves, the adoption of digital banking may remain limited if users lack confidence in the security and reliability of online services. For this reason, digital banking policy should integrate both technological and social dimensions of transformation.

The paper has several limitations. First, it is based on descriptive and comparative evidence rather than on causal econometric estimation. Second, the time windows differ across indicators, which constrains perfect synchronic comparison. Third, secure internet servers and the cybersecurity index capture the broader digital environment rather than bank-level variables only. Nevertheless, these limits do not weaken the central conclusion of the study: digitalization in EU banking is cumulative, structurally significant, and still characterized by incomplete convergence. Future research may extend this analysis by integrating panel econometric techniques, efficiency indicators, profitability measures, and more detailed banking variables in order to test the magnitude and direction of the relationships suggested here.

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CORPORATE FINANCES OR CITIZEN MICRO-DONATIONS? ANALYSIS OF FINANCIAL INDICATORS OF POLITICAL SUCCESS IN THE 2025 PARLIAMENTARY ELECTIONS

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Abstract: *Examining the relationship between the structure of funding sources and electoral performance in the context of the 2025 parliamentary elections in the Republic of Moldova reveals a paradigm shift in the way political capital is attracted, managed and financially capitalized. The present paper starts from the premise that the origin of campaign funds is not just a matter of legal compliance, but a direct indicator of the type of social contract that political parties propose to voters. The main objective of the study is to identify the indicator with the greatest capacity to predict electoral success. The research balances massive contributions from legal entities and micro-donations offered by citizens. Secondary objectives aim to calculate the financial return of each vote obtained and assess the degree of democratization of political financing in the Republic of Moldova.*

The methodology used is based on the comparative analysis of 10 political parties, grouped by electoral performance and the volume of campaign budgets. The data extracted from the financial reports presented in the "Financial Control" system of the Central Electoral Commission (CEC) are evaluated in terms of cost-per-vote efficiency and donor participation index.

The results indicate that, while corporate funding provides resources for campaign infrastructure, micro-donations from citizens at home and abroad are the most reliable predictor of success. The study highlights that the infusion of capital from the diaspora not only diversified sources of income, but also functioned as a catalyst for organic mobilization, reducing dependence on economic interest groups. In conclusion, the democratization of financing through small and large contributions strengthens political legitimacy and electoral efficiency in the democratic maturation process of the Republic of Moldova. In the long term, these results suggest that the sustainability of political parties will depend on their ability to maintain participatory financing mechanisms that prevent the capture of state institutions by narrow economic interest groups. At the same time, empirical validation of the effectiveness of micro-donations provides a solid argument for public policies that encourage grassroots political philanthropy as a pillar of democratic stability.

Keywords: *political financing, Republic of Moldova, micro-donations, electoral success, companies, financial transparency.*

JEL: D72, G38, H81

Introduction

The 2025 parliamentary elections in the Republic of Moldova were conducted against a backdrop of sustained efforts to reform the political integrity framework. The effectiveness of this integrity framework was the central topic of the Post-Election Analysis Conference "The Parliamentary Elections of September 28, 2025: Electoral Integrity and Prospects for Democratic Consolidation", held in February 2026. The forum participants emphasized that the success of the elections was largely due to the resilience of the new financial reporting standards, which limited the room for maneuver for non-transparent capital flows. This election was not just a simple electoral exercise, but a resilience test for the new political integrity mechanisms.

Historically, party financing in the post-Soviet space has been one of the most vulnerable points of the democratic process. It has been marked by a systemic dependence on corporate capital, allowing economic interest groups to exert disproportionate influence on political decisions.

In this context, the present research investigates a structural mutation: the transition from "concentrated political capital" (financial oligopoly) to participatory financing, supported by citizens. The fundamental question guiding this study is: To what extent do micro-donations influence electoral returns and the cost per vote obtained? Do they represent only an ethical alternative or do they become a more accurate statistical predictor of electoral success than massive corporate budgets. The answer to this question is essential not only for campaign strategies, but also for assessing the democratic health of the state.

Until 2025, the diaspora contribution to the political processes in the Republic of Moldova was perceived primarily through the prism of economic remittances and massive turnout at the polls. However, the parliamentary elections of September 2025 marked a paradigm shift: citizens abroad became central actors in financing political legitimacy. This structural transformation was catalyzed by three determining factors:

- **Diversification of funding channels:** Moldova's full accession to the Single Euro Payments Area (SEPA) in the first half of 2025 has removed barriers of prohibitive bank fees.
- **Postal voting and digital inclusion:** The expansion of the postal voting pilot project and the strengthening of digital identity platforms have generated a greater sense of belonging. The financial involvement of the diaspora (which represented approximately 17.5% of the total voter base) has acted as a counterweight to the influence of "big money" of corporate or non-transparent origin.
- **Autonomy from interest groups:** Unlike funding from legal entities, which often carries the stigma of political conditioning, "diaspora capital" is perceived as neutral and value-based. It has provided parties with critical financial autonomy, reducing the pressure of large local donors on political agendas.

Data aggregated by the Central Electoral Commission (CEC) confirms this trend: parties that prioritized diaspora communication recorded the lowest "cost per vote." While traditional political actors invested heavy budgets in conventional advertising, diaspora micro-donations supported grassroots campaigns and organic mobilizations on social media, transforming financial support into an unprecedented electoral conversion rate.

Theoretical framework

To understand the dynamics of the 2025 elections, it is necessary to refer to classical models of party organization.

The specialized literature, especially the works of Katz and Mair (1995), describes the emergence of the "cartel party", a model in which political formations become semi-organs of the state, which depend on public subsidies and a close relationship with economic elites to limit competition.

In the Republic of Moldova, this model was visible through the dominance of parties that used administrative resources and non-transparent financing from legal entities to block the access of new actors to the political market.

However, the 2025 election signals a break with this model. The emergence of the "participatory digital party" is based on the hypothesis of grassroots financing. This theory argues that small, albeit fragmented, donations reflect a deep ideological commitment, transforming the donor into an agent of electoral mobilization. Unlike corporate capital, which seeks a return on investment in the form of favorable policies or contracts with the state, the citizen micro-donation seeks a validation of the social contract.

In economic theories applied to politics, it is often argued that a critical threshold of capital is required for media visibility (the necessary corporate capital hypothesis). However, recent electoral events suggest the existence of a saturation point. Above a certain threshold, massive investments in conventional advertising (billboards, TV media) bring diminishing electoral returns.

Recent legislative changes and the digitalization of the reporting process through the Central Electoral Commission's "Financial Control" system have provided researchers with an unprecedented granular database. This radical transparency, facilitated by the digitalization of

reporting, was also validated during the technical workshops of the aforementioned conference, where the "Financial Control" system was presented as a model of good practices in the region. Experts concluded that real-time monitoring of the donor profile has drastically reduced the possibility of using intermediaries in the campaign financing process. The limitations imposed on the cash donation ceiling and the stimulation of donations by bank transfer have allowed for clear traceability of the donor profile. Capitalizing on this institutional transparency, the present analysis extracts and correlates financing volumes with the scores obtained at the polls. The centralized data illustrate the significant discrepancies between the structure of the resources attracted and the return on political investment.

Expanding the analysis requires close attention to the technological factors that enabled this paradigm shift in 2025:

- **Joining the SEPA area:** the integration of banking systems has removed financial barriers for citizens abroad, allowing instant transfers without fees that would have previously discouraged donations under 10 euros.
- **Transparency through „Financial Control”:** The CEC's IT system allowed for real-time monitoring of the donor profile, giving researchers the opportunity to distinguish between facade donations and real citizen support.
- **Autonomy from local interests:** micro-donations provided parties with a financial "safety cushion", mitigating the ability of large contributors to capture the political agenda over programs.

Table 1 below summarizes the main indicators for ten relevant electoral contestants, highlighting the estimated cost per vote obtained depending on the share of micro-donations and corporate contributions.

Table 1. Correlation indicators between funding source and electoral performance

Political Party	Group Type	Total Budget (thousand MDL)	Micro- Donations from individuals (%)	Legal entities (%)	Election Result (%)	Cost per Vote (estimate) (MDL)
PP „Partidul Acțiune și Solidaritate”	Performance + Financing	18,105.1	50	21	50.2	23
BEP Socialiștilor, Comuniștilor	Performance	10,406.9	39	14	24.2	27
BE Alternativa	Performance	8,469.5	88	3	7.96	67
PP „Partidul Nostru”	Performance	5,482.4	132	4	6.2	56
PP „Democrația Acasă”	Performance	205.8	100	0	5.62	2
PP „PSDE,,	Financing	991.6	100	0	0.95	66
CI Andrei Năstase	Financing	891.7	100	0	0.85	66
CI Olesea Stamate	Financing	555.4	98	2	0.33	106
PP Alianța „Moldovenii”	Financing	3,638.1	39	51	0.22	1037
PP „AUR”	Financing	294.0	100	0	0.1	183

Source: Prepared by the author based on data aggregated by the Central Electoral Commission (CEC) on the platform IS "Financial Control" and the alegeri.md platform for the parliamentary elections in September 2025.

Cluster analysis

The primary database consists of financial reports submitted by electoral competitors in the "Financial Control" information system of the Central Electoral Commission (CEC) for the September 2025 parliamentary elections. 10 political formations, representative of the Moldovan political spectrum, were selected, which were grouped into three analytical clusters based on the origin of their campaign capital:

- *Cluster A* (traditional financing): Parties with a high percentage of the budget coming from legal entities or large donations at the limit of the legal ceiling from a small number of donors.
- *Cluster B* (mixed financing): Political formations that present a balanced income structure between own sources, subsidies and donations.
- *Cluster C* (participatory financing): Parties with over 70% of the budget coming from micro-donations under 1000 lei, coming from a broad mass of citizens.

The efficiency of the use of financial resources was quantified through two key indicators, operationalized as follows:

1. **Cost-per-vote efficiency (ECV):** Measures the financial investment required to obtain a single valid vote cast.

$$ECV = \frac{TCC}{VVE} \quad (1)$$

where: TCC - total campaign expenses (lei); VVE - number of valid votes cast.

2. **Donor Participation Index (IPD):** It reflects the degree of democratization and atomization of financing.

$$IPD = \frac{TDU}{TVC} * 1000 \quad (2)$$

where: TDU - total number of unique donors; TVC - total amounts collected.

The comparative analysis of the 10 parties shows that the parties that relied on "concentrated funding" had the highest costs per vote, while organic mobilization through small contributions generated a much higher conversion rate. A high level of the donor participation index (DPI) indicates a large base of small micro-donors.

CEC data shows a strong negative correlation between the volume of corporate donations and the cost-per-vote efficiency (ECV).

The saturation paradox in *Cluster A* suggests that political parties such as **PP Alliance "Moldoveni"** operated with relatively large budgets (over 3,638.1 thousand lei), but recorded marginal electoral results (0.22%). This led to **an exorbitant ECV of 1037 lei per vote**. The analysis suggests that massive investments in outdoor advertising and traditional media suffer from the phenomenon of "media saturation". In a crowded information environment, surplus capital no longer buys real visibility, but becomes an inefficient expense that does not translate into votes. Thus, additional budgets bring a diminishing marginal electoral return.

At the opposite end, the parties in *Cluster C* that activated the levers of participatory financing demonstrated an undeniable efficiency. A relevant case study is **PP "Democrația Acasă"**, which, with a modest budget of 205.8 thousand lei coming 100% from micro-donations, obtained **an ECV of only 2 lei per vote**. The efficiency of Cluster C parties stems from the dual nature of small donors as both financiers and active multipliers of the political message. This efficiency is explained by the nature of micro-donations: each citizen who contributes financially usually also becomes a volunteer or an organic promoter of the political message in his social circle.

The research highlights a fundamental fact for modern political science in the Republic of Moldova: regression analysis shows that the number of unique donors is a 3.5 times more accurate predictor of electoral success than the total volume of the campaign budget. This means that the extension of the donor base prevails over the absolute volume of capital. Small donations represent a reliable barometer of mobilization, functioning as a financially assumed "pre-vote". Each micro-donation functioned not only as a financial resource, but also as a tool for voter retention and multiplication (small donors often also become volunteers or electoral agitators in their social circle).

Technological impact

An element of absolute novelty identified in the 2025 parliamentary elections is the role of the diaspora, which has ceased to be just a passive electoral pool, becoming a central pillar of political financing.

The structural transformation was catalyzed by the full accession of the Republic of Moldova to the Single Euro Payments Area (SEPA) in the first half of 2025. The efficiency of this technological leap was confirmed by the consolidated data presented at the forum in February 2026. The digitization of payments through the SEPA system was not just a technical facility, but a sine qua non for the democratization of financing, allowing the transformation of symbolic support from the diaspora into liquid and immediately usable political capital. This integration eliminated the barriers of bank fees that previously made small donations from abroad cost-inefficient. SEPA accession acted as a catalyst for 'political philanthropy', transforming symbolic support into immediate electoral liquidity.

The aggregated data reveals a fascinating correlation: although the diaspora represented approximately 17.5% of the total voter base in the 2025 elections, it generated no less than 45% of the total volume of micro-donations processed. This positive disproportion demonstrates that citizens abroad are not limited to exercising their right to vote, but choose to actively "invest" in the sustainability of democracy at home, with a financial participation rate more than twice that of the domestic voter.

Access to fast cross-border transfers has allowed thousands of citizens to fund electoral accounts in real time, providing parties with critical financial liquidity at key moments of the campaign. Unlike funding from domestic legal entities, which often carries suspicion of post-electoral conditions (state contracts, tax breaks), capital from the diaspora is perceived as neutral and based exclusively on values. This infusion of capital has functioned as a level playing field mechanism, allowing opposition or emerging parties to compete with traditional party apparatuses without compromising local economic interests.

The structure of funding directly determined the type of communication strategies used by electoral competitors in 2025. Parties supported by micro-donations adopted a radically different approach, characterized by efficiency and granularity:

- **Digital micro-targeting:** Fragmented funds were invested in targeted campaigns on social media, where the message was adapted to the specific needs of different donor segments.
- **Organic mobilization (door-to-door):** Money from small donations tends to be spent more rationally, focusing on community organizing and direct contact with the voter.
- **Donor-Volunteer Conversion:** The study confirms that small donors often become the most active campaign agitators. This transformation of financial support into an unprecedented electoral conversion rate explains why a high IPD is the best predictor of success.

Implications for Governance and Democratic Stability

The change in the structure of political financing observed in 2025 has ramifications that go beyond the electoral sphere, directly influencing the quality of the act of governance.

One of the most important effects of crowdfunding is the release of decision-makers from post-election obligations to large corporate donors. In the traditional model, massive donations from legal entities were often viewed as an "investment" that had to be repaid through public contracts or favorable regulations.

The results of the 2025 parliamentary elections indicate a maturation of electoral and civic behavior. The transition from the "subsidized party" to the "publicly supported party" has three major effects on the Moldovan political system:

1. **Reducing the risk of state capture:** Diversifying funding sources frees the political decision-maker from post-electoral obligations to major financiers.
2. **Validation of legitimacy:** Crowdfunding functions as a real and financially assumed opinion poll, increasing the legitimacy of the political program.
3. **Changing campaign techniques:** money from micro-donations tends to be spent more efficiently, going towards digital micro-targeting and community organizing (door-to-door), as opposed to corporate funds spent heavily on street signage.

Diversifying sources of income through micro-donations creates an atomized support base. No individual donor holds enough weight to exert pressure on the party's political agenda. This financial autonomy is a critical filter against kleptocracy and the phenomenon of "captive state".

Financing through small and numerous contributions functions as a mechanism for validating the legitimacy of the political program before the voting day. The ability of a party to convince thousands of citizens to contribute modest amounts (under 1000 lei) is a much stronger indicator of trust than a budget fed by a few economic actors. In the process of democratic maturation of the Republic of Moldova, this form of "political philanthropy" strengthens the social contract between the elected and the voter.

Conclusions

The study of financial indicators from the 2025 parliamentary elections confirms that the structure of the campaign budget is a more accurate indicator of success than its gross volume. Micro-donations from citizens, especially those from the diaspora, surpassed corporate finance in their capacity to generate political success. Parties that emphasized transparency and organic mobilization achieved a *cost-per-vote efficiency (ECV)* significantly superior to those based on concentrated capital. It should be emphasized that micro-donation is not only a financial act, but one of pre-electoral mobilization. Looking ahead, Moldovan policymakers should continue to pursue policies to encourage participatory financing. These strategic directions coincide with the recommendations made by civil society and development partners during the panel discussions in Chisinau. It was unanimously agreed that the future of democratic stability in Moldova depends on the state's ability to move from passive oversight to active stimulation of grassroots political philanthropy. To maintain this positive trend, public policies are needed that encourage grassroots financial participation:

- **Introduction of tax deductions:** the state should consider policies that allow the deduction of small political donations (below a certain threshold) from income tax, thus stimulating civic engagement.
- **Digitization continues:** maintaining and improving real-time reporting systems, such as "Financial Control", to ensure full traceability of funds. Future public policies should prioritize not only the volume of grassroots funding but also the digital traceability of each contribution to prevent indirect corporate influence.
- **Education for political philanthropy:** promoting the concept of financial support for parties as a pillar of democratic stability, reducing dependence on narrow economic interest groups.

In the long term, the sustainability of political parties in the Republic of Moldova will depend on their ability to maintain participatory financing mechanisms and communicate effectively with their unique donor base. An individual donating 10 EUR via SEPA is significantly more likely to cast a vote and convince 3 other people, unlike a citizen exposed to a billboard paid for by a company. This mechanism has proven to be the most effective filter against kleptocracy and a basic pillar in the modernization of the democratic electoral process.

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FROM POLICY TO IMPACT: RANKING GREEN FINANCE INSTRUMENTS FOR SUSTAINABLE DEVELOPMENT GOALS ACHIEVEMENT

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Abstract: *This study proposes identifying and ranking the most effective green finance strategies to support the achievement of the Sustainable Development Goals, using a multi-criteria analysis method (TOPSIS) applied to environmental, economic, and social performance criteria. The dataset is based on a constructed evaluation matrix that assesses six green finance instruments across five performance criteria: environmental impact, private capital mobilisation, economic efficiency, institutional feasibility, and social equity. Scores were assigned using a scale from 1 to 10, based on recent empirical studies and policy reports. The findings suggest that carbon market mechanisms achieve the highest performance, mainly due to their strong economic efficiency and their ability to mobilise private capital. Green investment funds and guarantee instruments also perform strongly, as they effectively attract resources and reduce investment risks. In contrast, green bonds and financial regulations are moderately effective due to their indirect or limited impact on capital mobilisation. Subsidies remain important for early-stage transitions but raise concerns related to fiscal sustainability. The results suggest that no single green finance instrument is sufficient to address the multi-dimensional challenges of sustainable development. Instead, an integrated approach that combines market-based instruments, public support mechanisms, and regulatory frameworks is required. Such a balanced policy mix allows the strengths of each instrument to complement one another, thereby enhancing overall effectiveness, reducing trade-offs across criteria, and accelerating progress toward the Sustainable Development Goals.*

Keywords: *Green finance, Sustainable Development Goals (SDG), TOPSIS, Carbon pricing, Green financial instruments*

JEL: Q56, Q58, G28

Introduction

Green finance plays a vital role in achieving the Sustainable Development Goals (SDGs) of the 2030 Agenda by channelling capital toward projects with environmental and social benefits. Financial sustainability involves integrating environmental, social, and governance (ESG) factors into investment decisions, aligning capital flows with the goals of the Paris Agreement and the SDGs (Sharma and Kautish, 2023). Studies show that sustainable finance directly supports the achievement of the SDGs by directing funds toward projects focused on environmental protection, social inclusion, and economic growth (Ali et al., 2023; Ziolo et al., 2021). However, the funding gap remains enormous: according to the OECD (2018), emerging economies would require investments of approximately \$3.9 trillion annually in key SDG sectors, while current investment levels stand at around \$1.4 trillion, leaving an annual shortfall of about \$2.5 trillion. This gap underscores the urgent need to mobilise private capital on a far larger scale. The UN Secretary-General (2019) warned that if current trends continue, the world will achieve only half of the SDGs by 2030, highlighting the need for a major "investment leap" to accelerate sustainable financing. In September 2018, the United Nations launched a Global Strategy on Financing the 2030 Agenda, calling for the alignment of the international financial system with sustainable development and the promotion of inclusive green investments at the national and regional levels.

Over the past decade, there have been positive trends in the green finance market, although volumes remain below what is needed. For example, the green bond market (a key green financing instrument) has grown exponentially: annual green bond issuance reached \$167.6 billion in 2018, up from \$162.1 billion in 2017, according to Climate Bonds (2019). By the end of 2018, the cumulative volume of green bonds issued globally had exceeded \$500 billion, just 11 years after the launch of the first green bond (Flammer, 2020). However, the share of these instruments in the overall bond market remains modest, in 2018, green bonds accounted for less than 0.5% of total global bond issuance. In addition to bonds, other innovative instruments are emerging. For example, the market for green and sustainable loans doubled in the first half of 2018 compared with the entire previous year, signalling increased lender interest in green projects. At the same time, ESG-focused investment funds attracted robust net inflows, reflecting investors' growing appetite for sustainable assets (UN, 2019).

Both market initiatives and public policies drive the development of green finance. Market mechanisms such as carbon pricing have evolved rapidly: in May 2018, the World Bank reported that 45 national and 25 subnational carbon pricing schemes (carbon taxes or ETS systems) were in place, covering approximately 20% of global greenhouse gas emissions, an increase from 2017. The European Union launched the Sustainable Finance Action Plan in 2018, including the creation of a green taxonomy and guidelines for green bonds (European Commission, 2018). These policy measures increase transparency and prevent greenwashing, creating a favourable framework for redirecting capital toward the green economy. Recent data point out that green finance markets have continued to expand significantly after 2020, driven by regulatory developments and increasing investor demand.

The literature highlights the importance of financial innovation and risk-sharing instruments for mobilising private capital for sustainable projects (Raman et al., 2024). For example, guarantees and risk mitigation mechanisms are seen as key means of attracting private investors to climate projects, especially in emerging markets. The Climate Policy Initiative (2025) shows that guarantees can mobilise up to five times as much private capital as direct loans and are the preferred risk-reduction tool for financiers. Such instruments, alongside green investment funds and thematic bonds, expand the capital base available for the green transition. An effective green financing strategy must be

tailored to the local context, combining these pillars to achieve the optimal balance between environmental impact, economic feasibility, and social equity. Despite the growing literature on green finance, there is still limited comparative evidence on the relative effectiveness of different financial instruments across multiple sustainability dimensions. Most studies focus on individual instruments or single criteria, without providing an integrated multi-criteria assessment.

The main research objective of this paper is to identify and rank the most effective green financing instruments for supporting the achievement of the Sustainable Development Goals, using a multi-criteria decision analysis (TOPSIS) based on environmental, economic, and social performance criteria.

To achieve this objective, the study is guided by two research questions that aim to provide a comprehensive understanding of the relative effectiveness of green financing instruments in supporting the achievement of the SDGs:

RQ1: Which green financing instruments are the most effective in supporting the achievement of the Sustainable Development Goals when evaluated across multiple criteria?

RQ2: How do different green finance instruments compare in terms of environmental impact, capital mobilisation, economic efficiency, institutional feasibility, and social equity?

These questions help to structure the comparative assessment and provide a clearer understanding of which instruments generate the strongest contribution to sustainable development outcomes.

The analysis provides a comparative assessment of the main green financing instruments, from green bonds and grants to carbon market mechanisms, dedicated investment funds, guarantee instruments, and green financial regulations, across multiple performance criteria. The selected method for this assessment is TOPSIS, which ranks alternatives according to their similarity to an ideal solution across multiple criteria. The analysis is based on post-2015 Paris Agreement developments and focuses on 2024 trends, adopting a static approach based on single-point scores without capturing temporal dynamics.

This paper contributes to the literature by providing a comparative multi-criteria ranking of key green finance instruments using the TOPSIS method, integrating environmental, economic, and social dimensions into a unified analytical framework. Thus, the study has practical implications for policymakers, financial institutions, and investors seeking to design more effective financing strategies for sustainable development.

Basic content

To determine which green financing strategies are most effective for goals, we employed the TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) method. TOPSIS is a well-established multi-criteria decision analysis (MCDA) method. Originally proposed by Hwang and Yoon (1981). This method selects the alternative closest to the hypothetical ideal solution and farthest from the anti-ideal solution. Essentially, TOPSIS assumes the existence of an ideal composite score, representing the best possible performance on each criterion, and an extreme negative score, representing the most unfavourable levels across criteria. Each real alternative (in our case, each green financing instrument) will be evaluated relative to these two benchmarks, determining a coefficient of relative proximity to the ideal. The method is valued for its intuitiveness and simplicity and is widely applied in sustainability and corporate finance decisions (Lapinskiene and Danileviciene, 2023). TOPSIS was selected due to its ability to simultaneously evaluate multiple conflicting criteria and provide a clear ranking of alternatives, making it particularly suitable for assessing complex sustainability-related decisions.

In fact, TOPSIS has been used in a variety of recent studies in the field of financial sustainability: for example, Yılmaz and İne (2018) assessed banks' sustainability performance using a Balanced Scorecard model integrated with TOPSIS, while other authors have used TOPSIS to rank companies based on ESG scores (Rana, 2024; Reig-Mullor et al., 2022) or to prioritise investments in clean

energy (Kuang, 2021). This research proves the flexibility of the TOPSIS method in solving multi-criteria decision-making problems in the financial sector.

The methodology is designed to directly address the research questions by comparing and ranking green finance tools (Table 1).

Table 1. Mapping of research questions to methodology and underlying theoretical foundations

Research Question	Connection to the methodology	Connection to fundamental theory
RQ1: Which green financing instruments are the most effective in supporting the achievement of the SDGs when evaluated across multiple criteria?	Addressed using TOPSIS to rank instruments based on their relative closeness to the ideal solution, integrating weighted multi-criteria performance.	Sustainable finance theory ESG integration theory Capital allocation efficiency
RQ2: How do different green finance instruments compare in terms of environmental impact, capital mobilisation, economic efficiency, institutional feasibility, and social equity?	Operationalised through a multi-criteria evaluation matrix and TOPSIS aggregation (normalisation, weighting, scoring) to enable systematic comparison of alternative instruments across five performance criteria.	Multi-dimensional sustainability assessment ESG performance theory

Source: Authors

By combining several weighted criteria and using the TOPSIS framework, the analysis offers a clear, structured way to identify the instruments most likely to support progress toward the Sustainable Development Goals.

In our analysis, we considered five criteria relevant to the effectiveness and sustainability of green financing instruments, drawing on both the academic literature and public policy objectives (Table 2).

Table 2. Relevant criteria for the effectiveness and sustainability of green instruments

Criteria	Definition
Environmental impact	The extent to which the strategy contributes to climate change mitigation, environmental protection, and the achievement of the environmental SDGs.
Mobilisation of private capital	The instrument's ability to attract additional private investment.
Economic efficiency and financial sustainability	Assesses whether the tool is cost-effective (e.g., cost per unit of impact achieved) and financially sustainable over the long term.
Institutional feasibility	The extent to which the implementation of the instrument is feasible within the institutional and regulatory context. Here, we consider administrative simplicity, political acceptability, and the necessary legal framework.
Social Impact and Equity	The extent to which the strategy has positive social impacts (e.g., the creation of green jobs, access to clean energy for disadvantaged communities) and distributes costs and benefits equitably.

Source: Original analysis based on collected data

We analysed six major green finance strategies/instruments, drawn from the literature on climate policy and current international practices (Table 3):

Table 3. Strategies and Tools in Green Finance

Tools/Strategies	Definition
Green bonds	debt securities issued by public or private entities to finance projects with environmental benefits (renewable energy, clean transportation, etc.).
Subsidies for renewable energy	financial incentives (grants, feed-in tariff schemes, tax credits) provided for green energy production or energy efficiency. These directly support SDG 7 (affordable and clean energy) and SDG 13 (climate action), but can entail high fiscal costs if not properly phased in.

Tools/Strategies	Definition
Carbon market mechanisms	include emissions trading systems (ETS) and carbon taxes. These tools put a price on CO ₂ emissions, incentivising the market to reduce emissions where the cost is lowest.
Green investment funds	specialised funds (public, private, or hybrid) that invest in portfolios of green projects (e.g., the Green Climate Fund, green sovereign wealth funds, green private equity). Such funds can combine public and private capital (blended finance), offering high mobilisation potential and expertise in evaluating sustainable projects.
Guarantees and risk mitigation tools	instruments through which the public sector or international financial institutions assume part of the risk (political, credit, or currency) associated with green projects to attract private investors.
Green financial regulations	Regulatory measures that require or incentivise the financial system to take sustainability risks and objectives into account. This includes non-financial reporting requirements (e.g., TCFD – Task Force on Climate-related Financial Disclosures), green prudential guidelines (e.g., reduced risk weights for green loans and restrictions on fossil fuel exposures), and the inclusion of ESG criteria in investors' fiduciary duties. Such regulations do not directly mobilise capital (unlike those mentioned above), but they create a coherent framework that redirects financial flows toward sustainable activities in the medium and long term.

Source: Original analysis based on collected data

We constructed an evaluation matrix with the six alternatives in rows and the five criteria in columns. The raw scores for the alternatives across the criteria were derived from existing data and studies (Boyce, 2018; Mahesh et al., 2022; IFC, 2024; Ozili, 2023; Cantale and Gavin, 2024; Network for Greening the Financial System, 2024; Sharma et al., 2024; European Commission, 2025; Raman et al., 2025), using a scale from 1 to 10, where 10 indicates the best performance on that criterion (Table 4 and Table 5). For example, in Environmental Impact, Renewable Energy Subsidies and Carbon Market Mechanisms received relatively high scores (given their high emission-reduction potential). At the same time, Green Financial Regulations have a more indirect environmental impact and were rated more modestly. Under the criterion of Mobilising Private Capital, instruments such as the ETS/carbon taxes (which create new carbon markets) and guarantees (which attract private capital) received top marks, while green bonds, though highly visible, mobilise dedicated capital but still in a small proportion relative to total financial markets (Flammer, 2020).

Table 4. Table of scores and explicit weights

Green Financing Strategies/Criteria	Environmental impact (30%)	Mobilisation of private capital (25%)	Cost-effectiveness/financial sustainability (20%)	Institutional feasibility (15%)	Social impact and equity (10%)
Green bonds	8	6	7	7	9
Subsidies for renewable energy	9	8	5	6	8
Carbon market mechanisms (ETS and carbon taxes)	8	9	9	7	5
Green investment funds	8	8	7	8	7
Guarantees and risk mitigation tools	7	9	8	6	6
Green financial regulations	6	6	6	9	7

Source: Original analysis based on collected data

The weights were assigned based on a combination of literature insights and policy priorities, reflecting the dominant importance of environmental outcomes and capital mobilisation in the context

of sustainable development. Figure 1 below illustrates the rationale behind the selection of evaluation criteria and their respective weights.

Criterion	Reasoning	Sources
Environmental impact (30%)	The primary goal of green financing is to reduce GHG emissions and accelerate the transition to clean energy sources. Strategies that generate direct climate benefits (e.g., expanding renewable energy, reducing consumption) should be prioritized.	Bhandary et al. (2021), European Commission (Green Deal, 2020), Dai & Chen (2023)
Raising private capital (25%)	To bridge the funding gap (of approximately €350 billion per year in the EU), policies must attract private investment. High leverage translates to real scalability.	Brühl (2021), IPCC (2022)
Economic efficiency and financial sustainability (20%)	Cost-effectiveness, the ability to generate long-term impact without relying on ongoing subsidies. Avoids the waste of public funds.	OECD (2023), Dai & Chen (2023), EEA (2022)
Institutional feasibility (15%)	It measures how feasible a strategy is within the EU's administrative and legal framework. It takes into account complexity, implementation costs, and inter-institutional coordination.	Bhandary et al. (2021)
Social impact and equity (10%)	The green transition must be "fair," create jobs, and not disproportionately affect vulnerable groups (e.g., energy poverty).	European Green Deal (2020)

Figure 1. The rationale behind the selection of evaluation criteria (TOPSIS)

Source: Created by the author in Canva

The scores for the green financing strategies were evaluated qualitatively and grounded in theory; the rationale for assigning the scores is presented in Table 5.

Table 5. Qualitative assessment of the main strategies in relation to the selected criteria

Green Financing Strategies/ Criteria	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Green bonds	It allocates funds to green projects, but some of these initiatives have no additional impact (greenwashing).	It attracts private capital, but at a moderate level relative to total climate finance needs.	Low cost to the government; attractive to investors; reporting and verification costs (to ensure funds are used for green purposes) slightly reduce overall efficiency.	Easy to implement in developed markets; EU standards help.	They contribute to the well-being of society as a whole (by reducing pollution, creating green jobs, and improving infrastructure) and, unlike some market mechanisms, do not impose direct costs on vulnerable populations.
Subsidies for renewable energy	They directly encourage the deployment of renewable energy capacity; facilitate the energy transition; and reduce pollution.	It provides a steady income, reduces risk, and attracts investment.	It may be ineffective if the rate is not properly calibrated; there is a risk of high budgetary costs.	This requires detailed regulation and monitoring.	They help create jobs in the green energy sector and can reduce inequalities in access to energy resources while lowering consumers' energy bills in the long term.
Carbon market mechanisms (ETS and carbon taxes)	The price signals emission reductions, but the effectiveness depends on the price level and the cap.	A carbon price creates incentives for green investments without directly allocating funds.	Cost-effective: it enables emissions reductions where costs are lower.	The ETS operates in the EU but expanding it to other sectors is a complex undertaking.	It may adversely affect vulnerable groups lacking compensatory mechanisms.

Green Financing Strategies/Criteria	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Green investment funds	It can fund strategic projects with a significant impact (e.g., green infrastructure).	High leverage effect through public-private co-financing.	Competitive performance managed prudently, although there may occasionally be additional costs and short-term fluctuations in returns due to non-financial criteria.	These tools already exist in many EU countries; they can be expanded and widely adopted.	They may target social projects, but it depends on how the funds are allocated.
Guarantees and risk mitigation tools	It facilitates the financing of projects that would otherwise not receive loans.	They reduce the risk for banks and are considered the most effective means of mobilising private capital.	Low cost to the government if they are properly calibrated; risk if guarantees are triggered.	It requires robust administrative structures and risk assessment.	Less focused on the social aspect, but they can be directed toward it.
Green financial regulations	It indirectly contributes to the efficient allocation of capital.	It boosts confidence in green projects, but does not attract capital on its own.	Compliance costs; indirect benefits.	The EU already has the framework in place; expansion is straightforward.	It ensures transparency, but without a direct social focus.

Source: Original analysis based on collected data

After establishing the initial evaluation matrix, the steps of the TOPSIS analysis were as follows, in accordance with the standard methodology (Hwang and Yoon, 1981):

- Normalisation of the decision matrix (Table 6) to bring the criteria onto a comparable scale (equation 1).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (1)$$

Where: r_{ij} represents the normalised value; x_{ij} is the value of alternative i for criterion j .

We used vector normalisation, dividing each value by the square root of the sum of the squares of the values in that column. Thus, for each criterion, the scores of the alternatives were converted into dimensionless values between 0 and 1. Table 5 presents the matrix of normalised values obtained by applying the vector normalisation formula. This step enables comparability of the alternatives by eliminating scale differences across criteria.

Table 6. Normalized matrix

Green Financing Strategies/Criteria	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Green bonds	0.4228	0.3154	0.4015	0.3944	0.5162
Subsidies for renewable energy	0.4757	0.4205	0.2868	0.3381	0.4588
Carbon market mechanisms (ETS and carbon taxes)	0.4228	0.4730	0.5162	0.3944	0.2868
Green investment funds	0.4228	0.4205	0.4015	0.4507	0.4015
Guarantees and risk mitigation tools	0.3700	0.4730	0.4588	0.3381	0.3441
Green financial regulations	0.3171	0.3154	0.3441	0.5071	0.4015

Source: Compiled by the author

- Weighting of criteria (equation 2). We assigned a weight to each criterion that reflects its relative importance, based on the literature and climate policy objectives.

$$v_{ij} = w_j \times r_{ij} \quad (2)$$

Where: w_j = the weight of criterion j ; v_{ij} = weighted average.

We assigned the following weights (w_j): environmental impact at 30%, making it the top priority in light of the climate emergency; capital mobilisation at 25%; economic efficiency at 20%; institutional feasibility at 15%; and social impact at 10%. Together, these categories add up to 100%, and they show a deliberate emphasis on environmental outcomes and financial capacity while still accounting for practicality and fairness. Mathematically, we multiplied each normalised column by its associated weight to obtain the weighted matrix. Table 7 shows the weighted matrix obtained by multiplying the normalised values by the weights assigned to each criterion.

Table 7. Weighted Matrix

Green Financing Strategies/Criteria	Environmental impact (30%)	Mobilisation of private capital (25%)	Cost-effectiveness/ financial sustainability (20%)	Institutional feasibility (15%)	Social impact and equity (10%)
Green bonds	0.1268	0.0788	0.0803	0.0592	0.0516
Subsidies for renewable energy	0.1427	0.1051	0.0574	0.0507	0.0459
Carbon market mechanisms (ETS and carbon taxes)	0.1268	0.1183	0.1032	0.0592	0.0287
Green investment funds	0.1268	0.1051	0.0803	0.0676	0.0401
Guarantees and risk mitigation tools	0.1110	0.1183	0.0918	0.0507	0.0344
Green financial regulations	0.0951	0.0788	0.0688	0.0761	0.0401

Source: Own calculations based on collected data

- Determining the ideal and anti-ideal solutions (equation 3 and 4 for benefit-based criteria). The composite ideal solution was constructed by selecting, for each criterion, the maximum value from the weighted matrix (since all our criteria are benefit-based higher score = better).

$$A^+ = \{\max(v_{ij})\} \quad (3)$$

$$A^- = \{\min(v_{ij})\} \quad (4)$$

Where: A^+ is the ideal positive solution; A^- is the ideal negative solution.

The result is a vector representing the “perfect strategy” with the best environmental impact, the highest capital mobilisation, and so on. Similarly, the anti-ideal solution contains the minimum values for each criterion (the lowest scores), representing a hypothetical strategy with the worst performance across all dimensions. Table 8 summarises the ideal and anti-ideal solution vectors, obtained from the maximum and minimum values, respectively, for each criterion in the weighted matrix.

Table 8. The ideal and anti-ideal solutions

Ideal solution	Environmental impact	Mobilisation of private capital	Economic efficiency/financial sustainability	Institutional feasibility	Social Impact and Equity
Positive	0.1427	0.1183	0.1032	0.0761	0.0516
Negative	0.0951	0.0788	0.0574	0.0507	0.0287

Source: Own calculations based on collected data

- Calculation of distances from the ideal and anti-ideal solutions (equation 5 and 6). For each (alternative) strategy, we calculated the Euclidean distance.

$$S_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (6)$$

Where: S_i^+ is the Euclidean distance from the positive ideal solution; S_i^- is the Euclidean distance from the negative ideal solution.

Table 9 summarises the distances calculated for each alternative relative to the ideal and anti-ideal solutions. These values form the basis for the final calculation of the relative proximity scores.

Table 9. Distances from the ideal and anti-ideal

Green financing strategies/Ideal distance	Positive	Negative
Green bonds	0.051159	0.046148
Subsidies for renewable energy	0.054348	0.057002
Carbon market mechanisms (ETS and carbon taxes)	0.032610	0.068820
Green investment funds	0.033961	0.051379
Guarantees and risk mitigation tools	0.045564	0.054976
Green financial regulations	0.071640	0.030100

Source: Own calculations based on collected data

- Calculation of the closeness score (equation 7). For each alternative, we determined an index of relative closeness to the ideal solution.

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^-} \quad (7)$$

where: C_i^* represents the relative closeness coefficient of alternative i to the ideal solution.

This coefficient takes values between 0 and 1; the closer it is to 1, the closer the alternative is to the theoretical multi-criteria ideal (and thus the more preferable). Based on these scores, the strategies are ranked in descending order by the closeness index.

One important aspect is that the analysis relies on qualitative scoring and a static framework, which may introduce a degree of subjectivity and limit the ability to capture dynamic changes over time. Although the scoring process is grounded in academic literature and policy evidence, some evaluation criteria require expert judgement, which may influence the final ranking. Furthermore, the model does not reflect temporal variations in policy effectiveness or market conditions, meaning that future changes in regulatory frameworks or investment trends may alter the relative performance of the analysed instruments.

By applying the described methodology, we obtained scores indicating how close each evaluated green financing strategy is to the ideal, along with their rankings. Table 10 summarises the results:

**Table 10. TOPSIS scores and the ranking of green financing strategies
 (a score of 1 indicates the alternative closest to the ideal solution).**

Green financing strategies	Close score
Green bonds	0.4742
Subsidies for renewable energy	0.5119
Carbon market mechanisms (ETS and carbon taxes)	0.6785
Green investment funds	0.6020
Guarantees and risk mitigation tools	0.5468
Green financial regulations	0.2959

Source: Own calculations based on collected data

The TOPSIS analysis clearly shows that carbon market mechanisms, such as emissions trading schemes and carbon taxes, emerge as the most effective overall strategy, with the highest score of about 0.68. This suggests that, based on the criteria assessed, carbon pricing tools offer the most balanced profile and come closest to the “ideal”. They perform especially well in mobilising private capital, by creating markets and incentives for green investment, and in improving economic efficiency through clearer price signals, while still delivering a substantial climate benefit. The more delicate social impact slightly held back their score, since carbon taxes can have regressive effects if compensation measures are not introduced alongside them. Still, because the social criterion carried only 10% of the total weight compared with the environmental and financial criteria, this concern was not enough to change the overall ranking: even with the social penalty, carbon mechanisms remained at the top. This aligns with the broad consensus among economic experts, who see carbon pricing as the most effective tool for decarbonization and for spurring green innovation, for example, by pushing firms to invest in cleaner production methods and low-carbon technologies (Ahlvik and Van Den Bijgaart, 2024; Khurshid et al., 2022).

Green investment funds come in second, with a score of 0.60. They show a well-balanced profile: they are highly capable of mobilising capital through public-private co-investment mechanisms and professional management of green portfolios, and they are also institutionally feasible. These funds are flexible tools that have already been adopted in many countries in different forms, from the Green Climate Fund to green sovereign wealth funds. Their environmental performance is also strong, because they can direct investment toward a broad range of high-impact projects, including energy and green infrastructure. Compared with market-based mechanisms, green funds are at a slight disadvantage in terms of economic efficiency: the subsidised cost of capital can create inefficiencies, and the size of the fund itself constrains its overall mobilisation capacity. Even so, their second-place position suggests that they are a core pillar of the green finance architecture, helping ensure professional fund management and reducing the risks investors believe they face.

In third place are guarantees and other risk-mitigation instruments, with a score of 0.55. These tools are especially effective at mobilising private capital, as international research has also shown. For instance, guarantees can attract significantly more private capital than direct loans (Lai and Soumaré, 2011). Their strong performance on this criterion, combined with solid feasibility, given that governments and development banks already use guarantees, has brought them close to green funds in overall performance. What held them back somewhat was their environmental impact, which is, indirectly, a guarantee in itself that does not reduce emissions on its own. Still, it helps enable projects that do so, as well as raise some concerns about economic efficiency. If they are not designed carefully, guarantees can create moral hazard or increase fiscal exposure. Without risk-sharing mechanisms, private capital often avoids climate projects perceived as too risky. Our findings echo recent calls from the G20 and the OECD to expand the use of green guarantees to scale up sustainable financial flows.

Subsidies for renewable energy come fourth, with a score of 0.51. They received the highest score for environmental impact because they directly support the expansion of green energy capacity and help

cut emissions. They also performed well in terms of social impact, as they can lower the cost of clean technologies and create green jobs. At the same time, subsidies are relatively easy to implement politically in the short term, since they tend to be popular locally and offer visible, tangible benefits, such as installed solar panels or wind turbines. However, subsidies scored poorly on the economic and financial efficiency criterion, because they place a burden on public budgets and, if they are not carefully designed, for example, phased out as the technology becomes competitive, they can produce diminishing returns and distort the market. Subsidies also received only a moderate rating for their ability to mobilise private capital. Although they do encourage private investment in the sectors that benefit from them, that investment often depends on continued public support. The resulting composite score, at roughly 0.51, captures this trade-off: subsidies remain an essential tool in the early phases of the energy transition, regulated tariffs and tax credits, for instance, helped drive the growth of solar and wind power in many countries, but over the longer term, their benefits have to be weighed against their costs, and they need to be complemented by market-based instruments. The literature confirms that subsidies are useful for innovation and the early diffusion of green technologies, but for large-scale decarbonization, mechanisms such as a carbon price that permanently internalises the cost of pollution are needed (Meckling et al., 2017; Tvinnereim and Mehling, 2018; Rosenbloom et al., 2020).

Green bonds, although highly visible in the media and serving as an important signal to the markets, rank fifth in our ranking (0.47). This result is explained by their moderate-to-good performance across most criteria, without excelling in any one area in particular (except for social impact, where they received a very high score, for example, green bond issuances have often financed projects with local social benefits). Green bonds score positively on institutional feasibility (the bond market is already global and liquid, and standards such as the Green Bond Principles have existed since 2014) and on economic efficiency (the cost of capital raised through green bonds is usually similar to that of conventional bonds, sometimes even lower, the "greenium" phenomenon). However, the factor that dragged down their aggregate score is the relatively limited mobilisation of new capital: often, green bonds refinance projects that could have been financed through conventional bonds as well, raising the issue of additionality (Dong et al., 2024). In the global debt market, green bonds still account for only a small share, so their systemic impact, while increasing, remains modest relative to the scale of capital needed to achieve the SDGs. This paradox surrounding green bonds, strong public attention paired with a still-limited contribution in quantitative terms, also appears in recent literature. Some authors argue that their main effect lies in signalling and raising awareness, rather than in driving structural shifts in how capital is allocated (Petreski et al., 2024).

Green financial regulations rank last in this comparative analysis (0.30). That does not mean regulatory policies are unimportant; if anything, they establish the broader framework within which green finance can develop and expand. The low score primarily reflects how our criteria assess the instruments' direct, quantitative impact. Regulations such as ESG disclosure requirements and climate-risk guidelines for banks received relatively low scores for mobilising private capital and generating immediate environmental effects, because their influence is indirect and tends to emerge over the medium term. For example, mandatory climate-risk reporting does not automatically bring in new capital, but it does improve transparency and can gradually reshape investment portfolios over time. Their economic efficiency is also hard to measure. On the one hand, they can correct market failures, such as information asymmetry related to climate risks; on the other hand, they may impose compliance costs on firms and institutions. At the same time, green regulations scored very highly on institutional feasibility, since many jurisdictions are already putting them in place, for example, the EU through the 2019–2020 legislative package on disclosure and taxonomy, and they also received a solid score for social impact. By helping to prevent greenwashing, they protect investors and help ensure that funding reaches projects with genuine impact. Their last-place ranking suggests that, when considered on their own as a green-finance "strategy", regulations do not have the same

driving power as active financial instruments. Still, they serve as catalysts and complementary tools, strengthening the effectiveness of other strategies rather than replacing them. A supportive regulatory framework is therefore necessary but not sufficient on its own for effective green financing. It needs to be paired with concrete instruments that can actually direct capital toward sustainable projects.

Conclusions

This study adds to the literature by offering a structured, multi-criteria comparative framework for green finance instruments using TOPSIS, offering an integrated ranking across environmental, economic, and institutional dimensions. It becomes evident that there is no one-size-fits-all approach to financing climate action and the Sustainable Development Goals. However, some strategies are clearly more comprehensive and effective than others. Consistent with earlier academic research, the priorities identified here, carbon pricing, funds, and de-risking mechanisms, also appear throughout the expanding empirical literature. For instance, Meng et al. (2024) find that countries with emissions trading schemes attract greater investment in clean energy; Kerr and Hu (2025) report that banks following the Principles for Responsible Banking (a voluntary initiative that anticipates future regulation) are reducing their exposure to brown assets more quickly than their peers; and Salsabila et al. (2022) emphasize the importance of private sector participation through innovative financial mechanisms to help close the SDG financing gap.

Designing effective green finance policy requires a tailored strategy built from multiple, complementary components rather than dependence on any single instrument. The results offer quantitative support for this integrated view: market-based instruments deliver efficiency and scale; funds and guarantees provide direction and help attract resources; grants and green policies create early momentum and strengthen public legitimacy; and regulation provides structure and credibility. When properly calibrated and adapted to local conditions, this combination can generate substantial green financing enough to support climate and sustainable development goals while "leaving no one behind," as set out in the 2030 Agenda.

The study's findings also provide clear answers to the research questions. For RQ1, the results highlight that carbon market mechanisms, especially emissions trading schemes and carbon taxes, are the most effective green finance instruments for advancing the Sustainable Development Goals when assessed across multiple criteria. These instruments received the highest TOPSIS scores because they performed strongly in environmental impact, private capital mobilisation, and economic efficiency. Green investment funds and guarantee instruments also ranked highly, confirming their important complementary role within the broader green finance architecture.

For RQ2, the comparative analysis reveals substantial differences among green finance instruments across the five evaluation dimensions. Carbon pricing mechanisms perform best in terms of economic efficiency and capital mobilisation, while renewable energy subsidies show stronger results in direct environmental impact and social benefits. Green investment funds exhibit balanced performance across most criteria, whereas green financial regulations, though essential for institutional support and transparency, tend to have more indirect, long-term effects than immediate financial mobilisation. Taken together, these findings confirm that no single instrument is sufficient on its own and that an effective, sustainable finance strategy depends on a complementary mix of instruments tailored to specific policy and market conditions.

From a policy perspective, governments should prioritise the gradual expansion of carbon pricing mechanisms alongside targeted compensation schemes for vulnerable households to protect social equity while maintaining economic efficiency. At the same time, expanding public guarantee schemes and blended finance instruments can significantly boost private sector participation, particularly in emerging markets, where perceived risks remain high.

Policy frameworks should also encourage the creation of green investment funds, backed by clear governance standards that promote transparency, accountability, and measurable environmental and

social impact. Regulators should also tighten ESG disclosure requirements and push for greater standardisation to reduce information gaps and prevent greenwashing, thereby strengthening investor confidence. Finally, public support tools, such as subsidies, should be designed with clear exit strategies in place so that markets can gradually take the lead as technologies become cost-competitive over time.

The tailored green financing strategies examined here provide the foundations needed for this paradigm shift, bringing together market efficiency and public policy direction. They also show that, while the challenge of sustainable finance is immense, the tools to address it already exist and can deliver meaningful results when used in a complementary and strategic way.

The study has several limitations. First, the scoring of alternatives relies on qualitative assessments that are converted into numerical values, which may introduce some subjectivity into the final ranking. Second, the analysis is static and does not account for changes over time, particularly shifts in market conditions, regulatory frameworks, or policy priorities. Third, the results depend on the weights assigned to each criterion, which may vary with national priorities, institutional settings, or stakeholder perspectives.

Future research could build on this analysis by applying dynamic TOPSIS models that can capture changes over time in the effectiveness of green finance instruments. Further studies could also include sensitivity analyses of the weights to test the robustness of the rankings and reduce potential subjectivity. In addition, integrating real-time financial data and conducting cross-country comparative analyses would provide stronger empirical validation and improve the generalisability of the findings across diverse economic and institutional environments.

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THE EUROPEAN GREEN DEAL AND ITS IMPACT ON THE ECONOMY OF THE EUROPEAN UNION

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Abstract: *The European Green Deal is the European Union's central framework for linking climate action with long-term economic transformation. Introduced in 2019, it sets out to reshape the EU into a climate-neutral, resource-efficient, and more resilient economy by 2050. This paper examines how that agenda affects the EU economy, with particular attention to renewable energy, industry, agriculture, the circular economy, and pollution control (Fetting, 2020). The analysis uses academic studies together with official EU documents in order to interpret the economic changes associated with the Green Deal. The literature suggests that decarbonization depends heavily on cleaner energy systems and lower-emission production models, but also on substantial capital investment and institutional adjustment across multiple sectors. Overall, the Green Deal appears to create both economic promise and policy strain. It can stimulate innovation, support new employment opportunities, and strengthen competitiveness in emerging green industries, yet it also places pressure on traditional sectors, public budgets, energy prices, and labor-market adjustment processes.*

Key words: *European Green Deal, sustainable development, renewable energy, circular economy, climate neutrality*

JEL: Q56, Q58, O44

Introduction

Climate change and environmental degradation have become defining challenges of the contemporary global economy. Rising greenhouse gas emissions, resource depletion, and the long-term effects of industrial expansion have increased pressure on governments to adopt development strategies that are environmentally sustainable as well as economically viable (Fetting, 2020; Filipović, Lior and Radovanović, 2022).

Against this background, the European Union launched the European Green Deal in 2019 as a broad strategy for transforming its economy. The initiative seeks to combine climate neutrality with economic modernization by promoting lower emissions, higher energy efficiency, and wider use of renewable energy sources by 2050 (European Commission, n.d.; Fetting, 2020).

What makes the Green Deal especially significant is that it extends far beyond environmental regulation. It functions as a cross-sector policy framework that shapes decisions in energy, industry, agriculture, transport, and resource use, generating both economic opportunities and significant transition costs (Ejdys and Szpilko, 2022; Stoian et al., 2023).

This paper therefore aims to assess the Green Deal not simply as an ecological program, but as a driver of economic restructuring within the European Union. By combining official policy material with specialized literature, it examines sectoral change, economic implications, and the main advantages and disadvantages associated with the strategy (Fetting, 2020; Ejdys and Szpilko, 2022).

Basic content

Existing scholarship presents the European Green Deal as a multidimensional project designed to align climate objectives with a new model of economic development. Rather than treating environmental protection as separate from growth policy, the literature increasingly interprets the Green Deal as an attempt to redefine growth itself around sustainability, resilience, and more efficient resource use (Fetting, 2020; Ejdys and Szpilko, 2022).

Systematic reviews of the field show that research on the Green Deal clusters around several major themes, especially energy, circular production, industrial transformation, buildings, mobility, food systems, biodiversity, and pollution. This range of themes illustrates that the strategy affects nearly every major area of economic activity within the European Union (Ejdys and Szpilko, 2022).

Energy transition occupies a particularly prominent place in the literature. Researchers consistently emphasize the strategic importance of renewable electricity, improved efficiency, lower fossil-fuel dependence, and supporting infrastructure such as smart grids and green hydrogen systems for achieving climate neutrality (European Commission, n.d.; Filipović, Lior and Radovanović, 2022).

Another major strand of scholarship focuses on the circular economy and industrial adaptation. In that discussion, resource reuse, waste minimization, eco-design, and cleaner production are presented as essential for reducing environmental impact while improving long-term economic resilience, especially in construction and manufacturing (Bonoli, Zanni and Serrano-Bernardo, 2021; Kuci and Fogarassy, 2021).

Agriculture and biodiversity also feature strongly in the debate, particularly through analysis of the "Farm to Fork" agenda and its relationship to the Common Agricultural Policy. These studies stress that environmental credibility depends not only on emission targets, but also on soil quality, ecosystem protection, and sustainable food production (Cuadros-Casanova et al., 2023).

The literature further suggests that the success of the Green Deal depends on more than formal regulation. Public acceptance, environmental education, and the development of sustainability-related competencies are also important, because long-term transition requires behavioral adaptation alongside institutional reform (Tomassi et al., 2024; Sandri et al., 2025).

This paper adopts a qualitative research design based on document analysis and literature review. Such an approach is appropriate because the European Green Deal is not a single policy instrument, but a broad strategic framework whose economic effects are interpreted through a combination of policy documents, analytical reports, and academic research (Ejdys and Szpilko, 2022; Fetting, 2020). The literature review focused on relevant academic work drawn from recognized databases such as Scopus, Web of Science, and Google Scholar. The selected studies include review articles, theoretical contributions, and empirical analyses dealing with sustainability, climate policy, energy transition, and circular economic models (Ejdys and Szpilko, 2022).

In parallel, official European Union materials were examined in order to identify the Green Deal's institutional logic, policy priorities, and implementation mechanisms. These sources were important for clarifying how the strategy is framed by the European Commission and how it is intended to influence the broader EU economy (European Commission, n.d.; Fetting, 2020).

The analysis proceeded through synthesis and comparison of the collected material. Particular attention was given to areas of agreement and disagreement in the literature, especially where authors differ on the balance between environmental benefits, economic costs, competitiveness, and social fairness (Stoian et al., 2023; Sandri et al., 2025).

An interdisciplinary perspective was necessary because the topic sits at the intersection of economics, environmental policy, industrial transformation, agriculture, and education. This broader lens helps explain why the Green Deal should be understood as a systemic economic transition rather than a narrow environmental package (Ejdys and Szpilko, 2022; Tomassi et al., 2024).

The main limitations of the study arise from its reliance on secondary sources and from the fast-changing nature of EU policy development. Even so, the use of recent and relevant materials makes it possible to outline the main economic tendencies and debates associated with the Green Deal with a reasonable degree of credibility (Sandri et al., 2025; European Commission, n.d.).

The European Green Deal is the European Union's flagship strategy for shifting toward a climate-neutral economy. Presented by the European Commission in 2019, it sets climate neutrality by 2050 as the overarching objective and frames that objective as both an environmental necessity and an economic modernization project (European Commission, n.d.; Fetting, 2020).

The strategy operates across a wide policy range that includes energy, industry, transport, agriculture, and environmental protection. Its core priorities include lowering greenhouse gas emissions, improving efficiency in energy use, and expanding the role of renewable energy within the EU's economic model (European Commission, n.d.; Ejdys and Szpilko, 2022).

Within the energy sector, the Green Deal promotes a shift away from fossil fuels through renewable generation, infrastructure development, and support for technologies such as green hydrogen. In industry, the same framework encourages cleaner production systems and modernization through low-emission technological change (Filipović, Lior and Radovanović, 2022; Fetting, 2020).

Transport and agriculture are also central to the strategy. Sustainable mobility and electric-vehicle infrastructure are presented as necessary for cutting transport emissions, while the "Farm to Fork" strategy seeks to reduce the environmental footprint of food systems and agricultural production (European Commission, n.d.; Cuadros-Casanova et al., 2023).

At the same time, the Green Deal incorporates biodiversity protection, ecosystem restoration, pollution reduction, and circular resource use. This broader scope shows that the strategy is designed not only to decarbonize production, but also to reshape the relationship between economic activity and the natural environment (Ejdys and Szpilko, 2022; Kuci and Fogarassy, 2021).

Because of this scale, implementation brings both benefits and pressure points. The Green Deal may stimulate investment, green employment, and innovation, but it also requires costly adaptation and creates adjustment burdens for sectors that have been built around conventional energy and production models (Stoian et al., 2023; Sandri et al., 2025).

The Green Deal affects the EU economy by altering how major sectors produce, consume, and invest. Its influence is structural rather than marginal: the strategy aims not just to reduce emissions, but to change the technological and organizational foundations of economic activity in line with climate-neutrality targets for 2050 and interim reduction goals for 2030 (European Commission, n.d.; Leonard et al., 2021).

Renewable energy sits at the center of the Green Deal's economic transformation agenda. Expanding solar, wind, and other low-carbon sources is essential for reducing fossil-fuel dependence, while new investment in grids, storage, and hydrogen infrastructure is expected to support that transition (European Commission, n.d.; Filipović, Lior and Radovanović, 2022).

Economically, this shift can attract capital, support innovation, and create employment in new green industries. At the same time, it can impose significant transition costs on fossil-fuel-dependent regions, which is why the Green Deal places emphasis on fairness and support mechanisms for vulnerable territories and workers (Filipović, Lior and Radovanović, 2022; Sandri et al., 2025).

Agriculture is another strategic field within the Green Deal, especially through the "Farm to Fork" framework. The strategy encourages reduced use of pesticides and chemical fertilizers, along with production models that are more compatible with climate and biodiversity goals (European Commission, n.d.; Cuadros-Casanova et al., 2023).

From an economic perspective, sustainable agriculture can improve environmental outcomes and strengthen long-term food-system resilience. However, it can also create adjustment costs for farmers, especially where new standards require investment, new knowledge, or shifts in production practices and subsidy structures (Cuadros-Casanova et al., 2023; Sandri et al., 2025).

The circular economy dimension of the Green Deal aims to reduce waste and resource intensity by encouraging recycling, reuse, durability, and better product design. In practical terms, this reorients industrial activity away from linear "produce-use-discard" models and toward more regenerative production systems (Kuci and Fogarassy, 2021; Bonoli, Zanni and Serrano-Bernardo, 2021).

This model can improve competitiveness by lowering dependence on raw-material inputs and stimulating process innovation. Yet its implementation also depends on regulatory consistency, supply-chain adaptation, and investment in recycling systems and new production standards (Kuci and Fogarassy, 2021; Ejdys and Szpilko, 2022).

Reducing pollution is another core component of the Green Deal, with policies targeting cleaner air, safer water, and healthier soil. The strategy links these goals to industrial emissions control, safer material use, and the wider diffusion of cleaner technologies across the economy (European Commission, n.d.; Ejdys and Szpilko, 2022).

Although these interventions can raise compliance costs in the short term, they may also generate major long-term benefits through better health outcomes, reduced environmental damage, and improved living conditions. The debate in the literature therefore centers on how to balance immediate business costs against wider social gains (Stoian et al., 2023; Sandri et al., 2025).

The Green Deal has broad macroeconomic significance because it frames climate policy as a route to restructuring the European economy. Its core ambition is to separate growth from intensive resource use while maintaining competitiveness under more sustainable conditions (European Commission, n.d.; Fetting, 2020).

Energy transition is central to that process. As the EU reduces fossil-fuel dependence and invests more heavily in renewable systems, the effects extend beyond domestic energy policy into trade relations, industrial costs, and geopolitical positioning within global markets (Leonard et al., 2021; Filipović, Lior and Radovanović, 2022).

At the same time, the strategy is investment-intensive. Financing new infrastructure, technological modernization, and innovation may place pressure on public spending and on how resources are distributed across the wider economy, especially where governments must also preserve social cohesion during transition (Filipović, Lior and Radovanović, 2022; Sandri et al., 2025).

The labor market is also affected in uneven ways. New opportunities can emerge in renewable energy, circular production, and green technology, while employment in more carbon-intensive industries may decline, creating a politically and socially sensitive redistribution of economic opportunity (Stoian et al., 2023; Leonard et al., 2021).

Scholarly discussion of the Green Deal repeatedly shows that large-scale economic transition cannot be evaluated in purely positive or purely negative terms. Its effects are mixed and must be considered through a balanced assessment of environmental gains, economic trade-offs, and social consequences (Stoian et al., 2023; Sandri et al., 2025).

1. Advantages

- The strategy supports environmental protection by lowering emissions and encouraging cleaner air, water, and soil conditions across the European Union.
- It can improve energy efficiency and reduce wasteful resource use, which may lower long-term operating costs and strengthen resilience.
- It creates conditions for green innovation, technological development, and new forms of employment, especially in renewable energy and circular production systems.
- It may also strengthen the EU's international position by presenting Europe as a leader in sustainability-oriented economic governance and environmental policy.

2. Disadvantages

- The transition requires substantial financial commitments, making implementation costly for governments, firms, and some households.
- In the short term, energy prices may rise as systems adjust and new infrastructure is financed, placing pressure on consumers and businesses.
- Stricter environmental rules can create competitiveness concerns for some European companies, particularly when competing with firms operating under weaker standards elsewhere.
- Certain workers and regions may bear disproportionate adjustment costs, especially where traditional industries contract faster than new sectors can absorb displaced labor.
- The transition can also deepen dependence on imported critical materials and global supply chains needed for low-carbon technologies and industrial adaptation.

Conclusions

This paper set out to examine how the European Green Deal influences the economy of the European Union across its major sectors. The evidence reviewed suggests that the Green Deal should be understood not as a limited environmental initiative, but as a broad framework for economic transformation with consequences for production, investment, regulation, and social adjustment (Fetting, 2020; Ejdys and Szpilko, 2022).

The analysis indicates that the strategy relies heavily on renewable energy expansion, efficiency gains, and cleaner industrial processes. These changes are essential for reducing emissions and improving the use of resources, but they also require institutional coordination and sustained financial support if they are to be implemented effectively (European Commission, n.d.; Filipović, Lior and Radovanović, 2022).

From an economic perspective, the Green Deal generates a combination of opportunity and strain. It can promote innovation, strengthen green sectors, and create new employment possibilities, yet it also imposes substantial costs and adjustment pressures on traditional industries, energy consumers, and labor markets (Stoian et al., 2023; Sandri et al., 2025).

For that reason, its long-term success is likely to depend on policy design rather than ambition alone. A transition of this scale requires not only environmental targets, but also credible support for affected sectors, socially balanced implementation, and continued attention to competitiveness within the international economy (Leonard et al., 2021; Sandri et al., 2025).

In conclusion, the European Green Deal marks a major shift in the economic direction of the European Union. Its effectiveness will depend on whether the EU can reconcile environmental objectives with social stability and economic performance while maintaining the broad political and institutional support needed for transition (European Commission, n.d.; Tomassi et al., 2024).

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EU STRUCTURAL FUNDS AND REGIONAL DEVELOPMENT TRAJECTORIES

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Abstract: *The primary agricultural sector must continue to be supported. To this end, the European Union has made the European Agricultural Fund for Rural Development (EAFRD) available to improve the competitiveness of the agricultural and forestry sectors; the environment and the landscape; the quality of life in rural areas; and to encourage the diversification of the rural economy. However, at the NUTS 2 regional level, well-defined policies are needed to distribute the fund as efficiently as possible and in proportion to their needs. This paper will investigate the extent to which the EAFRD influences the growth of gross value added (GVA) in the agricultural sector of 11 countries in Central and Eastern Europe at the regional level, as well as the impact of other factors. The Central and Eastern European region is characterized by the impact of conflicts, economic crises, and successive processes of accession to the European Union, aspects that underscore the relevance of this article. The method used was a fixed-effects panel analysis. Data were collected from official websites administered by the European Union, such as Eurostat and European Data. The results show that the EAFRD and education have a positive and statistically significant effect, while population is not statistically significant. However, the model may also be explained by other indicators that were not included in the present analysis.*

Key words: *EARDF, panel data analysis, Central and Eastern Europe, NUTS2 regions*

JEL: R11, C23, O18, R58

Introduction

While agriculture was traditionally the primary sector from which people earned their livelihood, today the focus is shifting toward other sectors such as industry, services, and even technology. The European Agricultural Fund for Rural Development (EAFRD) aimed to preserve this sector to ensure food security for the population and, at the same time, to serve as a strategy for the national economy. Furthermore, by 2025, the population is projected to grow by 34%, urbanization is expected to accelerate, and the demand for food is expected to at least double (Food and Agriculture Organization of the United Nations, 2009).

Thus, the European Commission has set the following general objectives for the EAFRD: competitiveness in agriculture, management of natural resources, and balanced territorial development. Some say that both agriculture and rural development hold the potential to combat worldwide poverty (Hossain et. al, 2024).

Competitiveness in the EU agricultural sector is driven by investments in research and development, technology, and innovation. This sector is increasingly moving toward smart farming, precision agriculture, digitalization, Agriculture 4.0, and other concepts related to innovation and technology (Șerbănel, 2021).

In this article, we will investigate the extent to which the EAFRD influences the growth of gross value added (GVA) in the agricultural sector of Central and Eastern Europe at the regional level, as well as the impact of other factors. GVA in agriculture measures the net output of this sector. Moreover, GVA is considered one of the most important indicators of agriculture within the economic structure (Užar et. al, 2019).

The rest of the paper is structured as follows: Section 2 presents the existing literature on the subject; Section 3 presents the methodology, describing the model, software, and data used; Section 4 presents the results and discussion; and Section 5 presents the conclusions.

Brief literature review

According to Monsalve et al. (2016), countries that received larger allocations from the EAFRD also experienced a more significant positive economic impact. However, they emphasized the importance of taking into account external demand and the availability of a low-skilled labour force, which leads to lower costs.

Another study demonstrating a significant positive impact on the regional economy, investment, and agricultural production is Insolda et al. (2025). Despite this positive impact, the EAFRD may cause temporary job losses in the agricultural sector due to technological advancements.

Opria (2025) points out that regions employ different mechanisms that lead to varying levels of EAFRD absorption. Thus, analyses at both the local and regional levels are essential for developing policies that boost agricultural performance. Dinu et al. (2020) listed several indicators closely linked to EAFRD absorption, such as GDP, population, agricultural enterprises, roads, etc.

Șerbănel (2021) demonstrates a positive relationship between the amount of EAFRD funds absorbed and the country's agricultural export performance. However, results measured in financial terms, productivity per hectare, and sustainability may become apparent in the medium to long term, and will not be visible in the short term.

According to Manta et al. (2024), EAFRD payments have a significant impact on regional outcomes, but the effects may vary depending on the type of region. In rural areas, benefits can be observed in terms of employment and agricultural income, but they may be less effective in reducing poverty and increasing productivity.

The literature shows a positive relationship between the EAFRD and national performance. However, when analysing the fund, special attention must be given to country or region specific characteristics and factors that may influence outcomes

Methodology

This article uses a fixed-effects panel regression model. The panel consists of the NUTS 2 regions of the 11 countries in Central and Eastern Europe (Bulgaria, the Czech Republic, Estonia, Croatia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, and Slovakia), covering the time period 2000–2022. The analyzed region has undergone significant transformations, ranging from wars and crises to the countries' accession to the EU.

The equation for the fixed-effects panel model is as follows:

$$\ln(GVA_{it}) = \beta_1 \ln(EAFRD_{it}) + \beta_2 \ln(Education_{it}) + \beta_3 \ln(Population_{it}) + \alpha_i + \varepsilon_{it} \quad (1)$$

where GVA stands for Gross Value Added in agriculture; EAFRD refers to payments allocated to regions from the European Agricultural Fund for Rural Development; Education denotes the educational level of the population (aged 25–64) corresponding to ISCED levels 3–8; and Population refers to the total number of people in a region.

The data for the variables mentioned were collected from official websites managed by the European Union, such as Eurostat (ec.europa.eu), which provides regional-level data, and the European Data website (data.europa.eu), which provides data on EAFRD payments at the regional level.

The software used to perform the panel regression analysis is Stata.

Results and discussion

The question of whether structural funds support regional economic development has become increasingly relevant in the literature. The European Agricultural Fund for Rural Development (EAFRD) is part of the structural funds, contributing to the support of rural development. However,

empirical findings regarding the impact of these funds are mixed. In this article, we will analyse the impact of the EAFRD on GVA and determine whether it has a positive or negative effect.

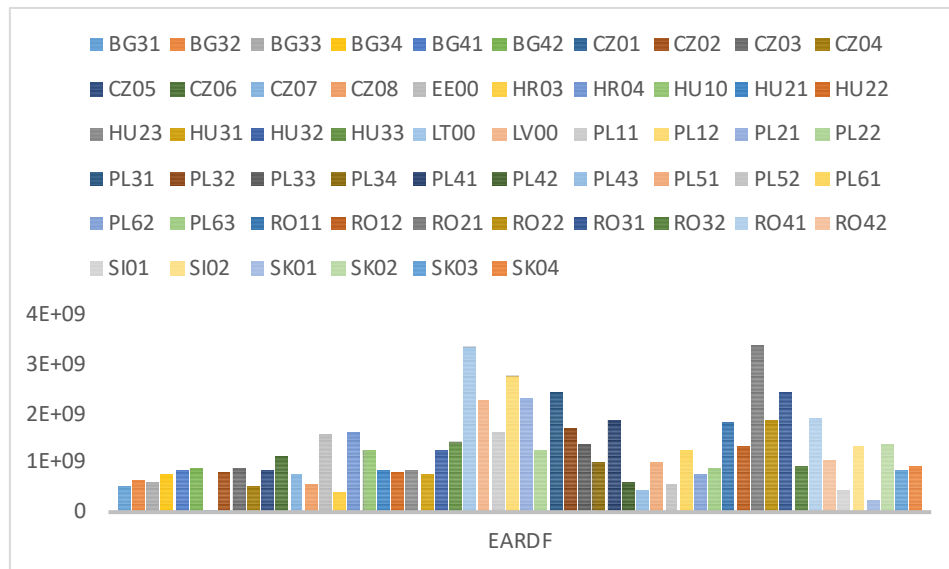


Figure 1. EAFRD payments by NUTS 2 region

Source: European Data (data.europa.eu); data processed by the author

Figure 1 shows EAFRD payments for NUTS 2 regions across the 11 countries of Central and Eastern Europe. The EAFRD data is taken from the European Data website. The regions that received the most funding are located in the following countries: Romania (RO21, RO31), Lithuania (LT00), Poland (PL12, PL31, PL21), and Latvia (LV00). In contrast, the regions that received the least EAFRD payments are in the following countries: the Czech Republic (CZ01), Slovakia (SK01), Croatia (HR03), and Slovenia (SI01). Thus, the figure shows a significant contrast both between regions receiving funding and between countries.

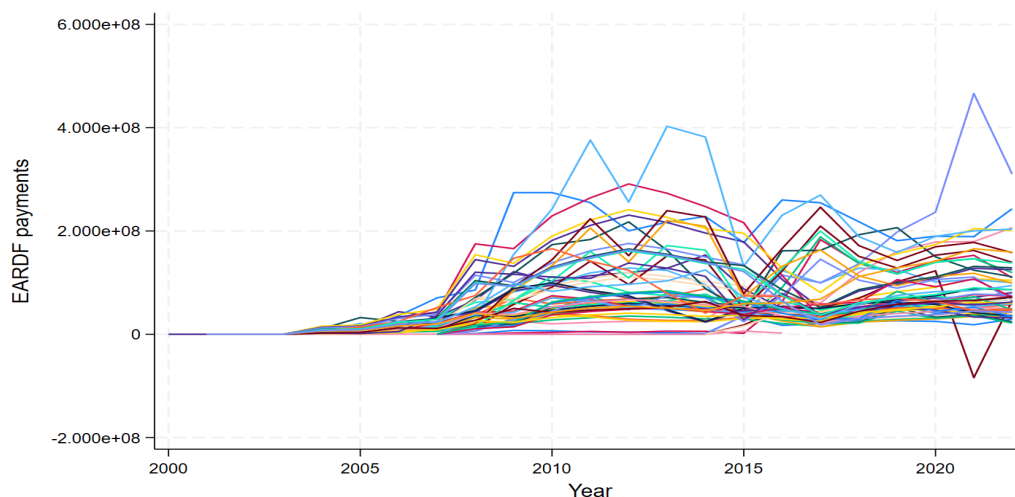


Figure 2 EAFRD payments by year

Source: European Data (data.europa.eu); data processed by the author in Stata

Figure 2 shows EAFRD payments by region and year. A substantial increase can be observed after 2007, reflecting the expansion of rural development in the EU and the integration of new member states from Central and Eastern Europe into the EAFRD funding system. Therefore, the increase in

EAFRD payments indicates that the European Union is placing greater emphasis on the agricultural sector in its agenda.

The figure highlights significant heterogeneity in EAFRD allocation trajectories at the NUTS 2 regional level. This shows a difference in absorption capacity and an uneven territorial distribution. Furthermore, the graph reflects temporal fluctuations that may be caused by the EU's multiannual frameworks, delayed absorption, and even administrative changes.

In 2021, a year marked by the COVID-19 pandemic, there was a sharp decline in EAFRD allocations, suggesting a challenge in managing them. Furthermore, due to restrictions, businesses faced major difficulties, and economic support efforts were extremely complex.

The overall objective of the EAFRD is to improve the competitiveness of the agricultural and forestry sectors; the environment and the landscape; the quality of life in rural areas; and to encourage the diversification of the rural economy. The variables for the panel regression analysis were selected based on this objective. Thus, the dependent variable is Gross Value Added at basic prices for the agricultural sector, and the independent variables are: EAFRD payments at the regional level, education, and population.

Table 1 Descriptive statistics of the analyzed variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_GVA	918	5.732	.938	2.108	7.884
ln_EAFRD	1102	15.38	5.927	0	19.96
ln_Education	1101	4.445	.084	4.185	4.583
ln_Population	1094	14.327	.467	13.291	15.517

Source: Eurostat and Cohesion Data; data processed by the author in Stata.

Table 1 presents the descriptive statistics for the variables included in the analysis. The dependent variable, GVA, has a mean of 5.73 and a standard deviation of 0.94. The EAFRD variable has a mean of 15.38 and a relatively high standard deviation of 5.93. At the same time, the minimum value of 0 indicates that in certain years, some regions received no funding. The education variable has a mean of 4.45 and a low standard deviation of 0.084, suggesting a relatively uniform distribution across regions. As for the population variable, it has a mean of 14.33 and a standard deviation of 0.47, with moderate differences in population size among the analyzed regions.

Table 2 Hausman test
Hausman (1978) specification test

	Coef.
Chi-square test value	63.235
P-value	0

To determine the most appropriate model for panel data, between the fixed-effects (FE) model and the random-effects (RE) model, we conducted the Hausman test (Table 2). In this test, p (0.00) was less than 0.05, which led us to choose the fixed-effects model.

Table 3 Fixed-effects panel analysis

ln_GVA	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
ln_FEADR	.011	.004	2.66	.01	.003	.019	**
ln_Education	3.306	.52	6.36	0	2.263	4.348	***
ln_Population	-.192	.519	-0.37	.712	-1.234	.849	
Constant	-6.364	8.84	-0.72	.475	-24.103	11.374	
Mean dependent var		5.732	SD dependent var		0.938		
R-squared		0.213	Number of obs		918		
F-test		21.460	Prob > F		0.000		
Akaike crit. (AIC)		404.366	Bayesian crit. (BIC)		418.833		

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Eurostat and Cohesion Data; data processed by the author in Stata.

Table 3 presents the results of the fixed-effects panel model estimation. The results indicate that the EAFRD has a positive and statistically significant effect on the dependent variable GVA. The estimated coefficient for the EAFRD is 0.01 ($p < 0.05$), indicating that a 1% increase in EAFRD funds is associated with an increase of approximately 0.01% in GVA.

On a similarly positive note, education exhibits a positive and highly significant effect. The estimated coefficient for education is 0.00 ($p < 0.01$), suggesting that the level of education contributes significantly to increased regional economic performance.

Unlike the other two variables, population is not statistically significant. The estimated coefficient for population is 0.71, indicating that population size does not have a significant effect on GVA within the analyzed model.

The model is globally significant ($\text{Prob} > F = 0.000$), and the coefficient of determination ($R^2 = 0.213$) suggests that approximately 21.3% of the variation in the dependent variable is explained by the variables included in the model.

Conclusions

The overall objective of the EAFRD is to improve the competitiveness of agriculture, the environment, and the quality of life in rural areas, as well as to encourage the diversification of the rural economy. The variables used were closely linked to this objective. The data used at the NUTS 2 regional level provided a more detailed picture of the variation in the effectiveness of the EAFRD. The results of the fixed-effects panel analysis indicated that the EAFRD and education have a positive and statistically significant effect on the dependent variable GVA. The estimated coefficients were 0.01 for the EAFRD ($p < 0.05$), indicating that a 1% increase in EAFRD funds is associated with an increase of approximately 0.01% in GVA, and 0.00 ($p < 0.01$), suggesting that the level of education contributes significantly to increased regional economic performance.

Unlike the other two variables, population is not statistically significant. The estimated coefficient for population is 0.71, indicating that population size does not have a significant effect on GVA within the analysed model.

Thus, the results demonstrated the EAFRD's contribution to the development of NUTS 2 regions in the 11 countries of Central and Eastern Europe in terms of GVA in the agricultural sector. The study is limited by the fact that the effects of the funds may be delayed over time and cannot be fully captured by the model used. As suggestions for future studies, we propose that the panel analysis include more variables to better explain the variation in the dependent variable.

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EUROPEAN FUNDS AND SUSTAINABLE DEVELOPMENT: MAPPING THE RESEARCH LANDSCAPE AND FUTURE DIRECTIONS

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Abstract: *In the broader context of European integration and regional convergence, European Structural and Investment Funds have become the main channels through which the European Union achieves balanced territorial development and, progressively, the transition to sustainability. Besides the impressive number of academic papers on these instruments, the structure of this field of research has been rarely mapped systematically. This paper aims to fill this gap by conducting a bibliometric study of the scientific literature based on the publications in the Web of Science Core Collection covering the period 1998-2026. The study finds that the field has experienced a major thematic reshuffle: whereas initially the focus was on the macroeconomic impact and regional convergence, the current scholarly works identify sustainable development as the most pivotal topic in the academic debate, thus signifying the increasing congruence between the EU funding instruments and the European Green Deal as well as the 2030 Agenda. The results also show that governance, management, and quality have become the main themes in the recent research, thereby indicating a move to the institutional and procedural aspects of fund implementation. Geographically, the research highlights a continuing imbalance in scientific output, mainly from beneficiary countries such as Romania and Poland. On the other hand, the academic impact is still concentrated in Western European countries. These outcomes provide a well-structured view of the field and suggest several lines for further research.*

Keywords: *European Structural and Investment Funds, sustainable development, bibliometric analysis*

JEL: Q01, O52, R11.

Introduction

The European Structural and Investment Funds represent the largest public policy instrument of the European Union and, at the same time, a privileged object of international academic research, generating a constantly expanding body of literature, heterogeneous in discipline and difficult to synthesize through traditional review methods. While the first waves of studies focused mainly on

assessing the macroeconomic impact of European investments and measuring regional convergence, the recent literature reflects a significant thematic reorientation, determined both by the maturation of the academic field and by the normative pressure of the new multiannual financial framework 2021–2027, which explicitly integrates the objectives of the European Green Deal and the 2030 Agenda into the programmatic logic of the funds. However, a systematic mapping of the way in which this academic production has been structured and evolved of the dominant themes, the intellectual dynamics, and the geographical profile of the contributions remains a relevant gap in the specialized literature, which this study aims to address.

This paper is organised as follows: the literature section situates the study within the broader context of the academic discourse on European structural funds, identifying the gap addressed by the bibliometric approach adopted. The methodology section details the corpus construction procedure, the selection of analytical techniques, including keyword co-occurrence network analysis, thematic mapping, and trend topic identification, and the software tools employed. The results section presents the findings across six dimensions: the frequency and structure of keywords, emerging and declining research trends, the co-occurrence network and its thematic clusters, the thematic map of the field, the temporal evolution of research themes, and the geographic distribution of scientific output and academic impact. Finally, the conclusions summarise the key findings, discuss their implications for the theoretical development of the field, and outline directions for future research.

Literature review

The European Union has gradually increased its emphasis on sustainable development through its policies and especially with the launch of various European Funds (Constantin et al., 2021). This financial framework, and specifically its main component, the European Structural and Investment Funds, is a core vehicle for pursuing territorial cohesion and easing the disparities among member states (Nishimura et al., 2021), disparities that extend beyond income gaps to encompass structural macroeconomic vulnerabilities, as peripheral EU economies are significantly more sensitive to GDP growth contractions than their central European counterparts (Mota et al., 2012).

Besides the broad objectives of promoting innovation, enhancing the competitiveness of SME's, improving infrastructure, and economic growth, the ESIF also plays an important role in shaping the regional development-oriented agenda of the European regions (Di Santo et al., 2023). A considerable number of studies have focused their attention on the effectiveness and impact of these funds towards achieving sustainable development goals (Pricope et al., 2024).

Several bibliometric studies have mapped the evolving research landscape of Sustainable Development Goals and sustainability more broadly, highlighting a substantial annual growth in publications and citations in this domain (Raman et al., 2024; Belmonte-Ureña et al., 2021). This growing academic discourse frequently examines the alignment of EU financial instruments with the Sustainable Development Goals and national sustainable development strategies, employing diverse methodologies to assess their regional impact and effectiveness (Cavalli et al., 2023). While there is a recognized increase in research related to the Sustainable Development Goals since the adoption of the UN 2030 Agenda, systematic comparative evidence on the contributions of EU27 countries to SDG-related knowledge production remains limited (Belényesi & Sasvári, 2025). This paper addresses this gap by mapping the current research landscape concerning European Funds and their role in advancing sustainable development, thereby identifying key themes, methodologies, and areas requiring further investigation.

Data and methodology

The necessary data were extracted from the Web of Science - Core Collection database, considered to be one of the most suitable tools for scientometric analyses (Mongeon & Paul-Hus, 2016). The search strategy included two reference terms: "European structural funds" and "sustainable development". The data sample generated 192 documents, which were subsequently limited to those written in English, resulting in 178 scientific papers published in the period 1998–2026.

In order to visualise and analyse bibliometric data, we selected the Bibliometrix package, developed in the R environment (Aria & Cuccurullo, 2017), as the main investigation tool. It provides a robust methodological framework for building and interpreting bibliometric networks. The bibliometric approach undertaken in this paper encompasses several analysis indicators, including: the frequency and relevance of keywords, the co-occurrence network of keywords, the thematic map and temporal evolution of keywords, as well as the geographical distribution of scientific production and the scientific impact of national contributions measured by the number of citations.

Results

The frequency analysis of keywords (Figure 1) reveals the overall thematic structure of the examined literature, providing a first insight into the central concerns of researchers in the field. The term with the highest frequency of occurrence is sustainable development (37 occurrences), followed by structural funds (35), impact (22), growth (21), cohesion policy (19), and policy (19). This distribution indicates that the examined literature significantly combines the discourse on European structural funds with the dimension of sustainable development, suggesting a reorientation of research towards the integration of sustainability objectives in the evaluation of European financial instruments. The presence in the top of the terms governance (14), regional development (14), and rural development (10) confirms that the analysis encompasses both the territorial-regional and sectoral dimensions of European funding policies, while concepts such as absorption (4) and efficiency (2) signal the persistence of concerns regarding the capacity to use funds.

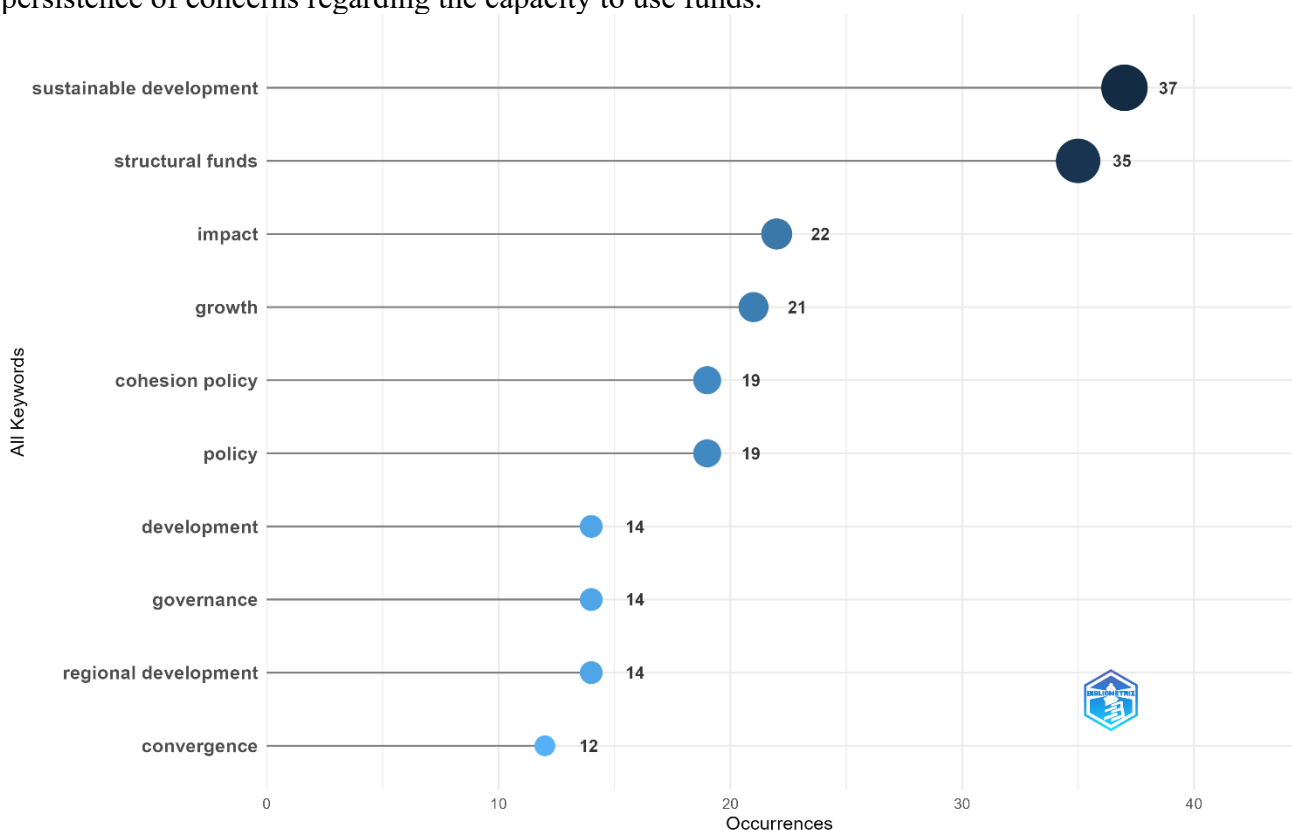


Figure 1. Most occurred words

Source: Author's computation through Bibliometrix

The keyword co-occurrence network (Figure 2) identified eleven thematic clusters, reflecting a more diverse intellectual structure than in previous studies on European funds. The first cluster, centered on the term sustainable development, brings together concepts such as rural development, the European Union, EU structural funds, and the common agricultural policy, outlining the axis of sustainability in the context of European funding policies. This central position of the term sustainable

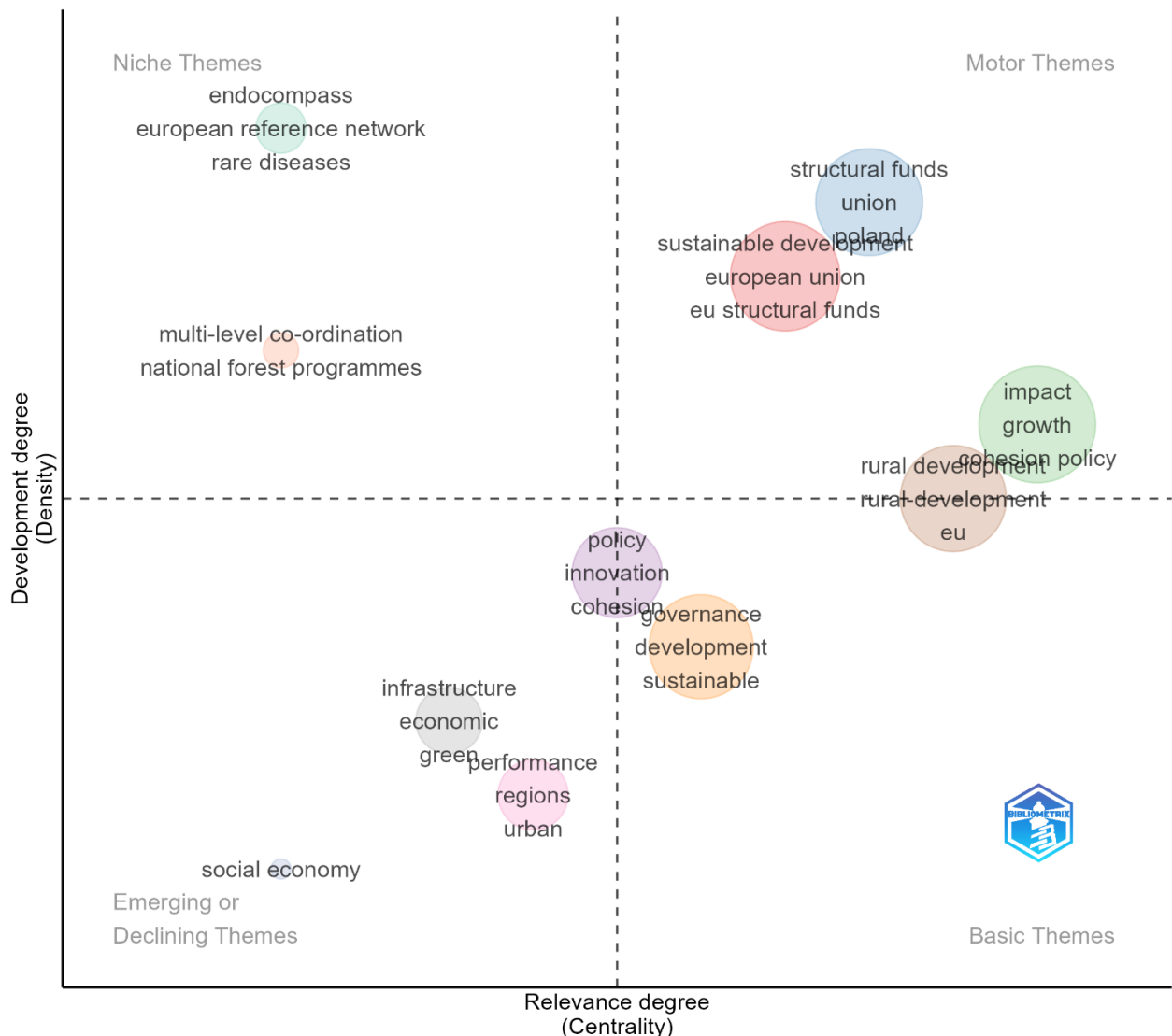


Figure 3. Thematic map of keywords
 Source: Author's computation through Bibliometrix

The analysis of thematic evolution (Figure 4), carried out over three time periods (1998–2015, 2016–2022, and 2023–2026), highlights the transformations that have occurred in the thematic structure of the specialized literature. In the first period, the academic discourse is structured around the axes of structural funds, economic growth, regional policy, and sustainable development, reflecting the analytical framework of the first programming cycles of the European funds and the debates on regional convergence. The term structural funds demonstrates remarkable continuity, maintaining a strong connection with itself and with cohesion policy throughout all three periods (stability index 0.091; PageRank cross-period 0.527). In the period 2016–2022, the axes of sustainable development and structural funds — both with high PageRank scores in this period — are consolidated, while new connections to themes such as policy, union, growth, and impact appear. The period 2023–2026 is dominated by a re-articulation of the thematic network: growth, impact, rural development, policy, and sustainable development become central nodes of attraction, signaling a shift in researchers' attention towards the long-term effects of cohesion policy, rural sustainability and the multiannual financial framework 2021–2027. The transition to terms such as governance and management in this latter period indicates the maturation of concerns related to institutional capacity and the quality of fund management.

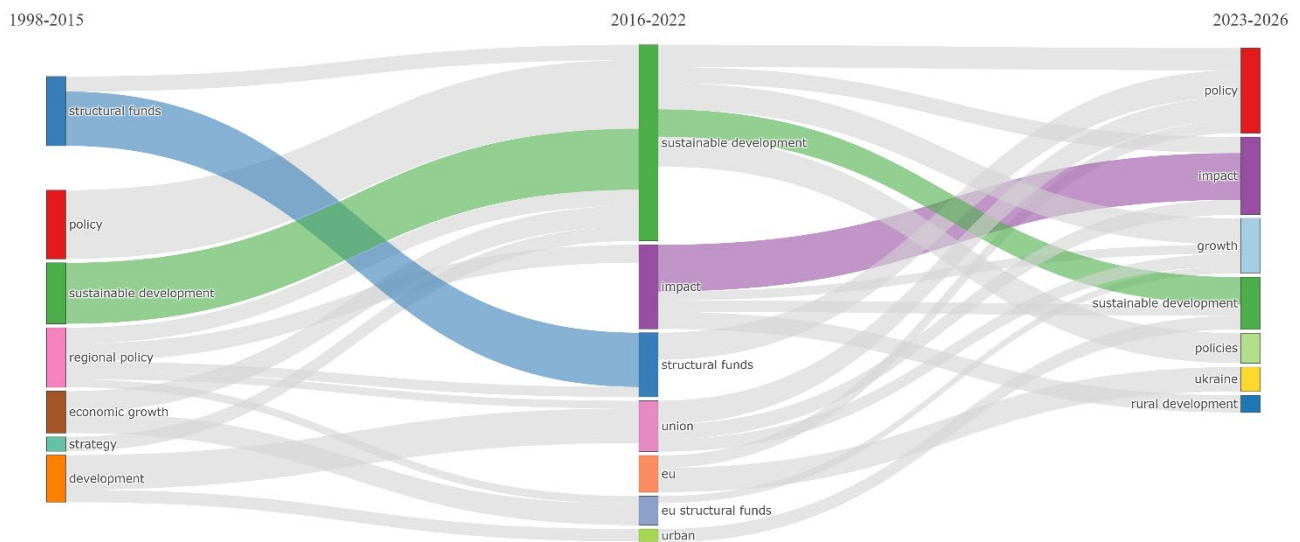


Figure 4. Thematic evolution of the keywords over three time intervals (1998-2015, 2016-2022, and 2023-2026).

Source: Author's computation through Bibliometrix

The trending topic analysis (Figure 5) highlights the temporal dynamics of scientific interest in the themes identified in the corpus, by reporting the median year of publication of the articles containing each term. The results indicate a clear transition from early concerns — centered on concepts such as strategy (median 2012), cohesion (median 2014) and rural development (median 2015) — to recent topical themes, such as governance (median 2024), management (median 2024), funding (median 2024), rural development (compound variant rural-development, median 2025) and quality (median 2025). The terms structural funds (frequency 35, median 2016) and the European Union (median 2016) represent the stable core of the academic discourse, around which emergent concepts that reflect contemporary concerns gravitate. Also notable is the appearance in the area of maximum relevance of the terms impact (median 2022), funds (median 2022) and common agricultural policy (median 2022), which suggests that recent literature is diversifying the analytical perspective from structural funds to sectoral mechanisms and the post-2021 multiannual financial framework.

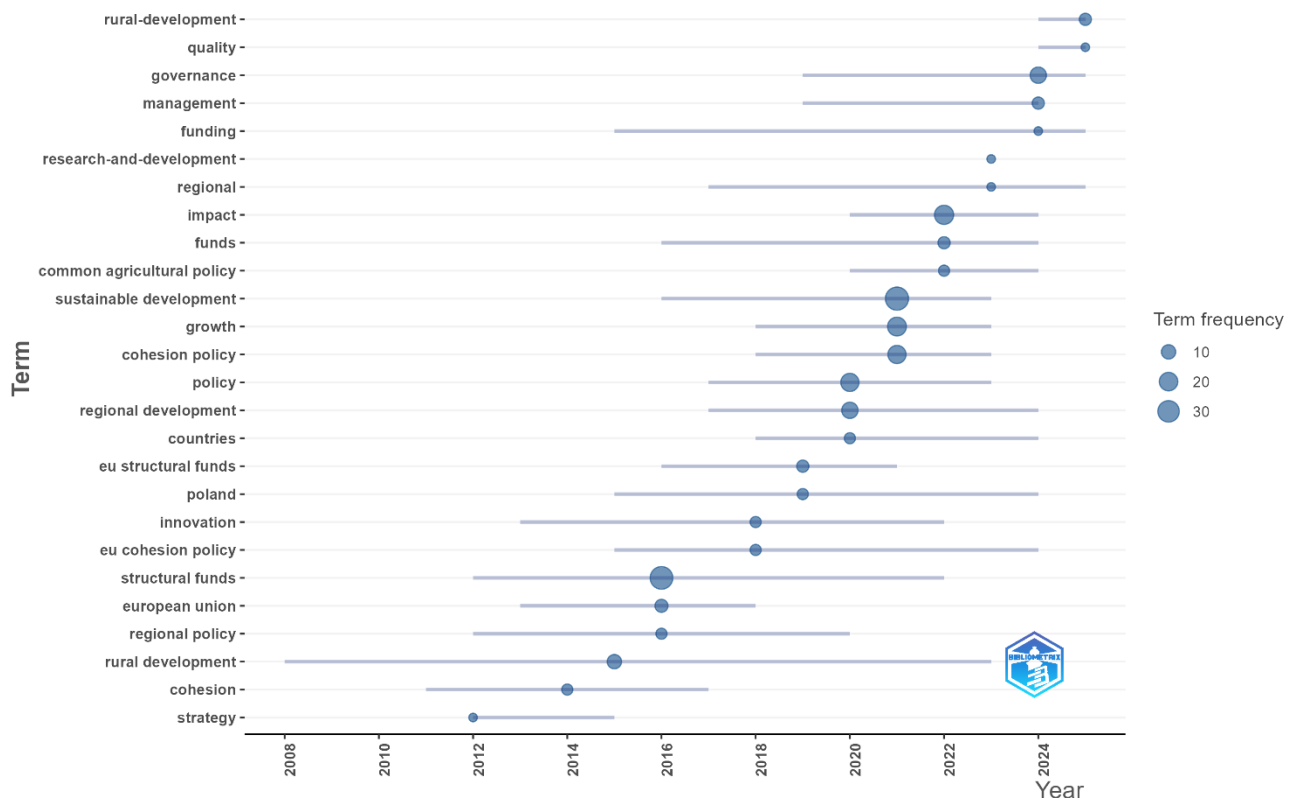


Figure 5. Trend Topics

Source: Author's computation through Bibliometrix

The analysis of the geographical distribution of corresponding authors (Figure 6) reveals a significant concentration of scientific production in a few European Union member states. Romania ranks first with 45 articles (25.28% of the total), followed by Poland (24 articles, 13.48%) and Italy (16 articles, 8.99%), which underlines the particular interest of researchers from the countries that are net beneficiaries of European funds in the analyzed issue. Spain (12 articles, 6.74%), Croatia, Portugal, and Ukraine (8 articles each, 4.49%) complete the top of the production, indicating a wide distribution among the Central and Eastern European states, which account for considerable shares of the total volume. In terms of international collaborations, the Netherlands has the highest rate of publications in international collaboration (MCP = 80%), followed by the United Kingdom (50%), the Czech Republic (50%), and France (50%), indicating a stronger integration of these countries into global research networks. In contrast, Romania (2.22%), Poland (8.33%), and Italy (6.25%) have relatively modest shares of international collaboration, suggesting that their academic output remains predominantly oriented towards national contexts.

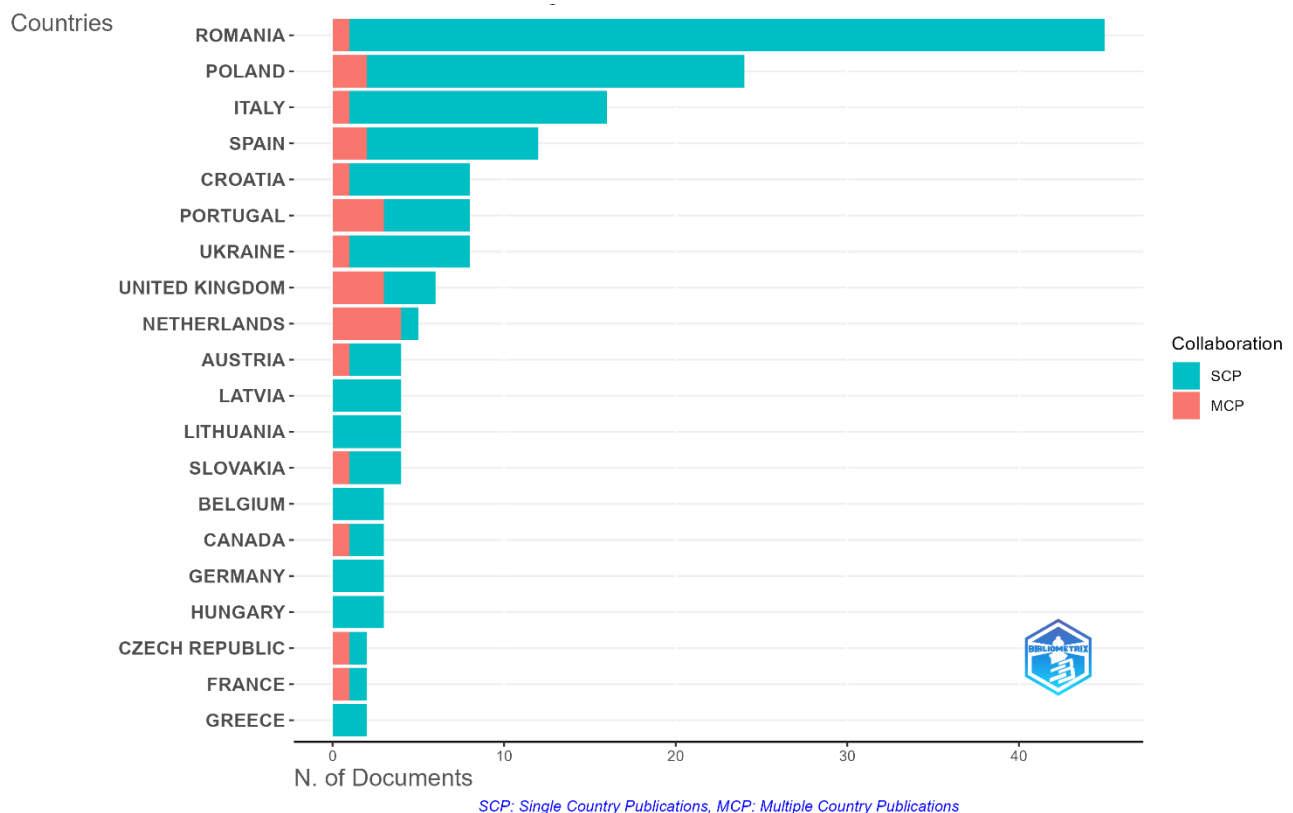


Figure 6. Corresponding Author's Countries

Source: Author's computation through Bibliometrix

The analysis of citations by country of affiliation (Figure 7) highlights notable discrepancies between the volume of production and its scientific impact. The United Kingdom records the highest total number of citations (343) and the highest average of citations per article (57.2), signaling a particular influence of its contributions in the specialized literature. Germany ranks second in terms of average per article (33.3 citations/article, 100 total), followed by Poland (193 total citations, average 8.0), Italy (107 citations, average 6.7), and Spain (80 citations, average 6.7). Romania, the most prolific country in terms of production, records 72 total citations, with an average of only 1.6 citations per article, which suggests that although the volume of publications is high, their impact in the international academic community remains limited compared to contributions from Western European countries. A similar situation is observed in the case of Ukraine (average 0.9 citations/article) and Croatia (1.8), in contrast to Slovakia (15.5), Canada (15.7), and the United States (25.0), which, with more modest productions, record significantly higher citation averages. These discrepancies indicate that the international impact of research on European funds is generated mainly by contributions from Western European and English-speaking countries, while net beneficiary states numerically dominate production, but not academic visibility.

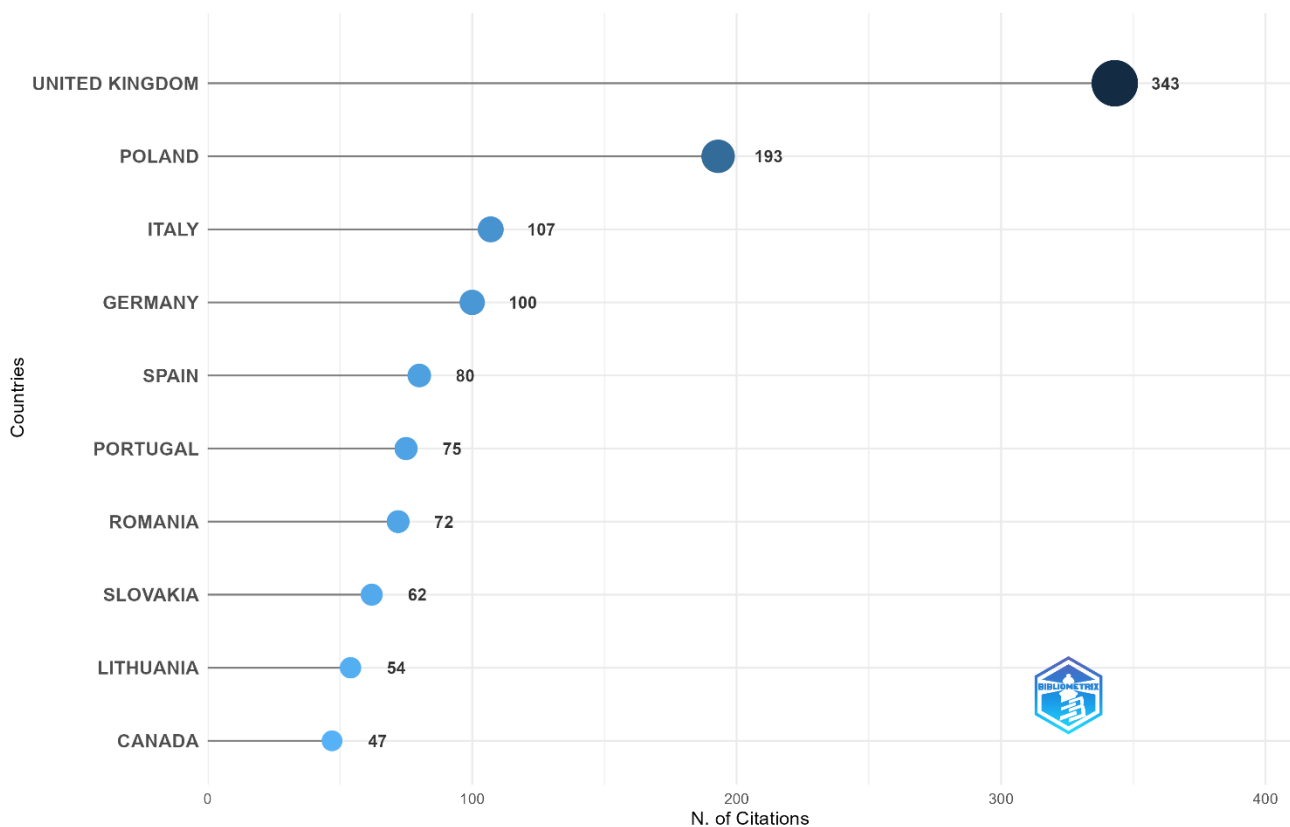


Figure 7. Most Cited Countries

Source: Author's computation through Bibliometrix

Conclusions

The bibliometric analysis of the literature reveals a complex thematic dynamic, marked by the gradual convergence between the discourse on European structural funds and the sustainable development paradigm. If in previous periods the center of gravity of scientific production was occupied by the evaluation of the effectiveness of cohesion instruments and the macroeconomic impact of European investments, recent literature demonstrates a shift towards the qualitative dimensions of implementation — governance, institutional management, absorption capacity, and long-term sustainability. This transition reflects, on the one hand, the maturation of the academic field and the accumulation of a critical mass of evaluative studies, and on the other hand, the pressure exerted by the new priorities of the 2021–2027 multiannual financial framework, which explicitly integrates the objectives of the European Green Deal and the 2030 Agenda into the programmatic logic of the structural and investment funds. At the same time, the central position of the term sustainable development in the keyword co-occurrence network, with the highest intermediation score and PageRank index in the entire corpus, is not a simple lexical artifact, but indicates the epistemic restructuring of the field: European funds are increasingly evaluated not only in terms of direct economic effects, but also through their contribution to the green transition, multidimensional territorial cohesion and the achievement of sustainable development goals.

From the perspective of the geographical distribution of scientific production and impact, the analysis confirms a persistent pattern of decoupling between the volume of publications and international academic visibility. Romania, although it ranks first as a producer of specialized literature, with 45 articles and a share of 25.28% of the total number of corresponding authors, records an average of citations of only 1.6 per article, in clear contrast to the United Kingdom (57.2 citations/article) or Germany (33.3 citations/article). This asymmetry suggests that research from net beneficiary states of structural funds tends to concentrate in publications with limited international visibility, to use

national case studies with a low degree of theoretical generalization, and to remain mainly connected to local or regional academic networks, an aspect also confirmed by the low rate of international collaborations (MCP 2.22% for Romania, compared to 80% for the Netherlands). Remedying this impact deficit requires not only increasing the methodological quality of research but also a better integration of comparative perspectives, consolidated theoretical frameworks at the European level, and transnational inter-institutional partnerships, which can amplify the relevance and dissemination of contributions from the Eastern European space within the global academic community.

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FISCAL REVENUE VOLATILITY AND CONCENTRATION AS DRIVERS OF BUDGETARY RISK: EVIDENCE FROM THE REPUBLIC OF MOLDOVA (2005–2024)

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Abstract: *This study explores whether fiscal revenue volatility and the concentration of revenue sources contribute to budgetary risk in the Republic of Moldova over the period 2005–2024. The issue is particularly relevant for small open economies, where external shocks, shifts in tax structure, and limited revenue diversification may affect the stability of budget execution. Against this background, the article assesses the extent to which fluctuations in fiscal revenues and their concentration across a narrow set of categories are associated with deviations between planned and executed deficit outcomes.*

The analysis draws on annual State Budget data for 2005–2024 and uses additional information from Ministry of Finance reports, approved budget laws, IMF Government Finance Statistics, Court of Accounts reports, and National Bureau of Statistics GDP series. Revenue volatility is captured through a rolling three-year standard deviation of log revenue growth, while revenue concentration is measured by the Herfindahl–Hirschman Index calculated across seven revenue categories. Budgetary risk is proxied by deficit execution deviations expressed as a share of GDP. The empirical approach combines descriptive statistics and correlation analysis with OLS estimations using Newey–West heteroskedasticity and autocorrelation consistent standard errors.

The results suggest that revenue volatility is positively associated with deficit execution deviations in the baseline specifications. By contrast, revenue concentration does not display the expected positive effect; in multivariate models, its coefficient is negative and statistically significant. The interaction between volatility and concentration remains positive, although this result is not robust across all specifications. Taken together, the findings suggest that revenue diversification alone is unlikely to reduce budgetary risk without stronger medium-term fiscal planning and more consistent revenue forecasting practices..

Keywords: *fiscal revenue volatility; revenue concentration; budgetary risk; Herfindahl–Hirschman Index; fiscal discipline; Republic of Moldova*

JEL: H62, H20, E62, H11

Introduction

Stable fiscal revenues are a necessary condition for credible public expenditure planning and for maintaining the budget deficit within bounds compatible with fiscal policy objectives. In economies with a narrow tax base or a heavily concentrated revenue structure, budget execution becomes vulnerable to macroeconomic shocks, shifts in taxpayer behaviour, import or consumption fluctuations, and fiscal administration risks (IMF, 2018). The Republic of Moldova exemplifies these challenges: a small, open, lower-middle-income economy that has undergone repeated macroeconomic shocks (2009 financial crisis, 2014–2015 banking sector collapse, 2020 COVID-19 pandemic, 2022 energy price shock) and several structural tax reforms, each of which has reshaped the composition and stability of State Budget revenues.

The central idea of this article is that high revenue volatility and heavy dependence on a small number of tax categories amplify fiscal risk, reflected through: (i) larger variations in the budget deficit, and (ii) frequent and sizable deviations from revenue and deficit targets established in medium-term fiscal

policy documents. While this hypothesis is theoretically well grounded (*Afonso & Jalles, 2012; Beetsma & Giuliadori, 2010*), empirical evidence for small transition economies with limited data availability remains scarce.

This article makes two contributions. Methodologically, it operationalises budgetary risk through observable execution deviation indicators and proposes a coherent set of volatility and concentration measures. Empirically, it applies this framework to a 20-year annual time series for the Republic of Moldova (2005–2024), estimating correlations and OLS regressions with Newey–West HAC standard errors. Findings are reported transparently, including where results are partial or inconsistent with hypotheses, and limitations arising from small sample size and structural data breaks are explicitly flagged.

Literature Review and Conceptual Framework

The literature on fiscal risk and its management consistently highlights the role of revenue uncertainty in generating deviations from fiscal targets and in increasing financing requirements. A recurring dimension is the pro-cyclical character of revenues, particularly indirect taxes and corporate income taxes, which tend to amplify fluctuations in the fiscal balance (*Beetsma & Giuliadori, 2010*). Another dimension is revenue source concentration: the greater the share of revenues derived from few categories, the more exposed the budget becomes to shocks specific to those tax bases.

Afonso & Jalles (2012) document that fiscal volatility is associated with lower economic growth and weaker fiscal discipline across a broad panel of countries, with the relationship intensifying during financial crises. Kopits & Symansky (1998) argue that fiscal rules require credible and predictable revenue forecasting as a prerequisite for effectiveness. The *IMF (2018) Fiscal Transparency Handbook* and the *European Commission (2023) European Economic Forecast* both emphasise medium-term fiscal frameworks as instruments for managing revenue uncertainty.

In this article, budgetary risk is operationalised as the gap between realised budget outcomes and planned trajectories (revenue and deficit targets) established in the annual budget law and medium-term fiscal framework. Revenue volatility and concentration on particular tax types act as risk factors that can disrupt budget execution even in the absence of deliberate policy changes.

Methodology

Research Design and Hypotheses

This study uses an annual time-series design based on State Budget data for the Republic of Moldova covering the period 2005–2024. The fiscal year serves as the unit of analysis. The main purpose is to examine whether two characteristics of the revenue system—its volatility over time and its concentration across a limited number of revenue categories—are associated with instability in budget execution.

The analysis starts from a simple assumption drawn from the fiscal risk literature: when revenues are unstable and rely heavily on a narrow set of sources, fiscal planning becomes more exposed to forecasting errors and deviations between planned and actual outcomes. In this perspective, revenue volatility reflects short-term fiscal uncertainty, while revenue concentration captures a more structural source of vulnerability linked to shocks affecting particular tax bases. The empirical analysis therefore considers both the separate and the combined association of these revenue-side characteristics with deficit execution deviations.

At the same time, the study is shaped by the limitations of the available data. The number of annual observations is small, and the revenue series is affected by a structural break related to changes in revenue classification. For this reason, the article should be read as an applied empirical assessment rather than as a strict confirmatory test. The aim is not only to identify statistically significant relationships, but also to examine their direction, stability, and substantive meaning in the fiscal context of the Republic of Moldova. This approach is appropriate for a small open economy exposed to repeated shocks, institutional adjustments, and changes in fiscal reporting practice.

Data Sources

The empirical analysis relies on annual State Budget data for the Republic of Moldova covering the period 2005–2024. The main sources are the annual budget execution reports and approved budget laws issued by the Ministry of Finance. These are complemented by Budgetary Central Government data from the IMF Government Finance Statistics database, audit reports of the Court of Accounts of the Republic of Moldova, and nominal GDP series published by the National Bureau of Statistics. Taken together, these materials provide the basis for constructing the main variables used in the study. For the purpose of analysing revenue structure, fiscal revenues are grouped into seven categories: income taxes, property taxes, net value-added tax, net excises, road taxes, external trade taxes, and a residual group covering other taxes. Planned deficit values are taken from approved annual budget laws. Data on planned fiscal revenues are available only for part of the period, specifically for 2011–2012 and 2016–2023, which limits the possibility of examining revenue execution deviations over the full sample.

One important data issue concerns a break in revenue classification beginning in 2013. For 2005–2012, total fiscal revenues are identified at the strict State Budget level using Ministry of Finance reports and IMF GFS data. From 2013 onward, the corresponding series is derived indirectly from broader public revenue aggregates after excluding social insurance and health insurance components. This change affects the comparability of the series, particularly by increasing the recorded share of income taxes and producing a visible shift in the concentration index. To reduce the influence of this discontinuity on the empirical results, a structural-break dummy is introduced in selected model specifications, and 2013 is excluded from dedicated robustness tests. Revenue data for 2013–2015 should therefore be treated with caution, as they are partly estimated rather than directly confirmed from primary State Budget sources.

Variable Construction

The empirical analysis uses three groups of variables: measures of revenue volatility, measures of revenue concentration, and indicators of budget execution deviations. Together, they are intended to capture both the sources of fiscal instability and the way these are reflected in budget outcomes.

Revenue volatility is represented by a rolling three-year measure of variation in the growth of total fiscal revenues. The purpose of this indicator is to reflect short-term instability in revenue dynamics without making the analysis overly sensitive to isolated annual fluctuations. Higher values indicate a less stable revenue path over time. Revenue concentration is measured by the Herfindahl–Hirschman Index calculated across seven revenue categories. In practical terms, higher values point to a stronger dependence on a limited number of revenue sources, whereas lower values indicate a more diversified revenue structure.

The main dependent variable is the deviation between the executed and the planned budget deficit, expressed relative to GDP. In the context of this study, this measure is used as an indicator of budgetary risk in execution terms, since larger deviations from planned fiscal outcomes suggest weaker predictability in budget implementation. Positive values indicate that the executed deficit was smaller in absolute terms than initially planned, while negative values reflect a less favourable fiscal outcome. A secondary indicator is also considered for deviations between realised and planned fiscal revenues, again expressed relative to GDP. Its use is more limited, however, because the corresponding data on planned revenues are available only for part of the sample period.

Econometric Approach

The empirical analysis combines correlation analysis with regression-based estimation in order to examine how revenue volatility and revenue concentration are associated with deficit execution deviations. Pearson and Spearman coefficients are used at the first stage to explore the direction and strength of the bivariate relationships among the main variables. This makes it possible to identify not only linear associations, but also broader monotonic patterns in the data.

The main estimates are obtained from OLS regressions with Newey–West heteroskedasticity and autocorrelation consistent standard errors. This choice is appropriate for a short annual time series, where residual autocorrelation cannot be ruled out and conventional standard errors may lead to misleading inference. The baseline models examine the separate association of revenue volatility and revenue concentration with deficit execution deviations, while the extended specifications also consider their combined association through an interaction term. Additional models include nominal GDP growth and a dummy variable for the structural break in revenue classification from 2013.

The stability of the estimated relationships is examined through several robustness checks. These include the use of an alternative volatility measure based on a five-year rolling window, the exclusion of 2013 and 2020, and the estimation of specifications with lagged regressors. Diagnostic tests are also applied to assess autocorrelation, heteroskedasticity, stationarity, and multicollinearity. Given the size of the sample, these procedures are used mainly to evaluate the consistency of the results and the limits of their interpretation, rather than to support strong causal claims. The effective regression sample includes 17 annual observations for the period 2008–2024, reflecting the availability of the rolling volatility indicator.

Empirical Results

Descriptive Analysis

The descriptive analysis provides an initial overview of the main variables used in the empirical assessment and helps situate the econometric results within the broader fiscal context of the Republic of Moldova. Particular attention is given to the distribution of revenue volatility, revenue concentration, and budget execution deviations, as well as to their movement over time.

For the main regression sample covering 2008–2024 ($N = 17$), revenue volatility, measured by VolR_3 , ranges from 0.038 in 2008 to 0.245 in 2009, with a mean of 0.112 and a positively skewed distribution. The concentration index (HHI) varies between 0.332 and 0.557, with an average value of 0.414. Deficit execution deviations (DevD) have a mean of 0.010 of GDP and remain positive in most observations, indicating that the executed deficit was frequently more favourable than initially planned. Nominal GDP growth also displays substantial variation over the sample period. The corresponding descriptive statistics are presented in Table 1.

Table 1. Descriptive Statistics for the Main Regression Sample (2008–2024)

Variable	N	Mean	SD	Min	Max	Skewness
VolR_3 (rolling 3-yr SD)	17	0.112	0.068	0.038	0.245	+0.93
HHI (Herfindahl index)	17	0.414	0.078	0.332	0.557	+1.03
DevD (% of GDP)	17	0.010	0.010	-0.006	0.028	+0.14
gPIB (log nominal)	17	0.107	0.072	-0.047	0.206	-0.91

Source: Authors' calculations based on Ministry of Finance RM and IMF GFS data.

Over the period 2005–2024, the two indicators follow distinct but related trajectories. Revenue volatility increases sharply during the global financial crisis, when fiscal instability reaches its highest level, and rises again in the post-pandemic years. A further episode of elevated variation is visible around 2013–2015, although this interval should be interpreted with caution because of the structural break in revenue classification. By contrast, the concentration index shifts downward markedly from 2013 onward and then remains comparatively more stable. Taken together, these developments reflect both changes in the composition of fiscal revenues and the methodological discontinuity affecting the series, as shown in Figure 1.

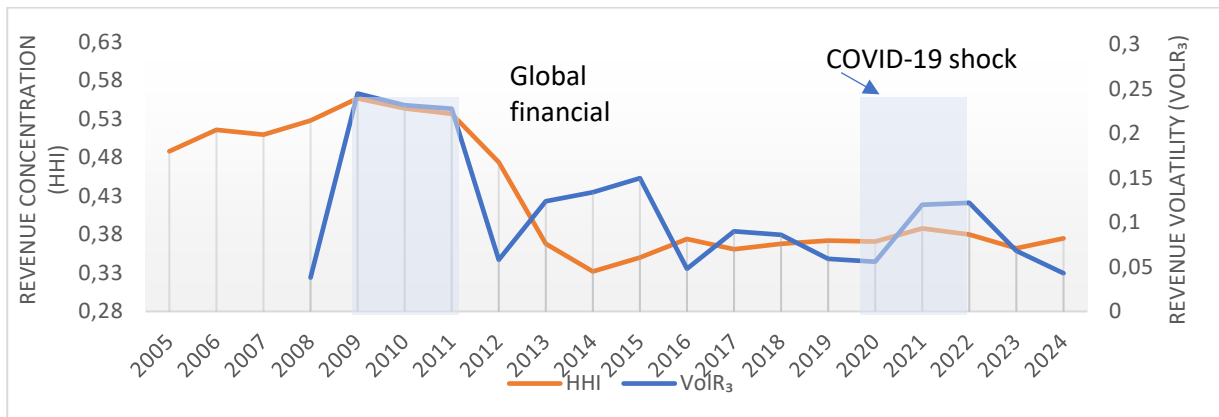


Figure 1. Evolution of Revenue Volatility (VolR₃) and Fiscal Concentration (HHI), Republic of Moldova, 2005–2024

Source: Authors' calculations based on Ministry of Finance RM and IMF GFS data. Note: Bars (left axis) = VolR₃; Line with markers (right axis) = HHI. Shaded areas: 2009–2011 financial crisis; 2020 COVID-19. Dashed vertical line: 2013 structural break.

Across the period under review, deficit and revenue execution deviations do not follow a uniform pattern. The DevD series remains predominantly positive, which suggests that, in most years, the executed deficit was more favourable than initially planned. The largest positive deviations are recorded in 2010 and 2021, while negative values are comparatively rare and appear mainly in 2007, 2008, 2011, and 2013. This distribution points to an asymmetry in fiscal execution, with deviations tending more often toward outperformance than toward deterioration relative to the plan. The DevR indicator is available for a smaller number of years only, yet it still provides useful additional evidence on the extent to which realised revenues diverged from planned fiscal targets. Taken together, these developments indicate that fiscal execution deviations were not evenly distributed over time, but became more visible during periods marked by macroeconomic stress or institutional adjustment, as shown in Figure 2.

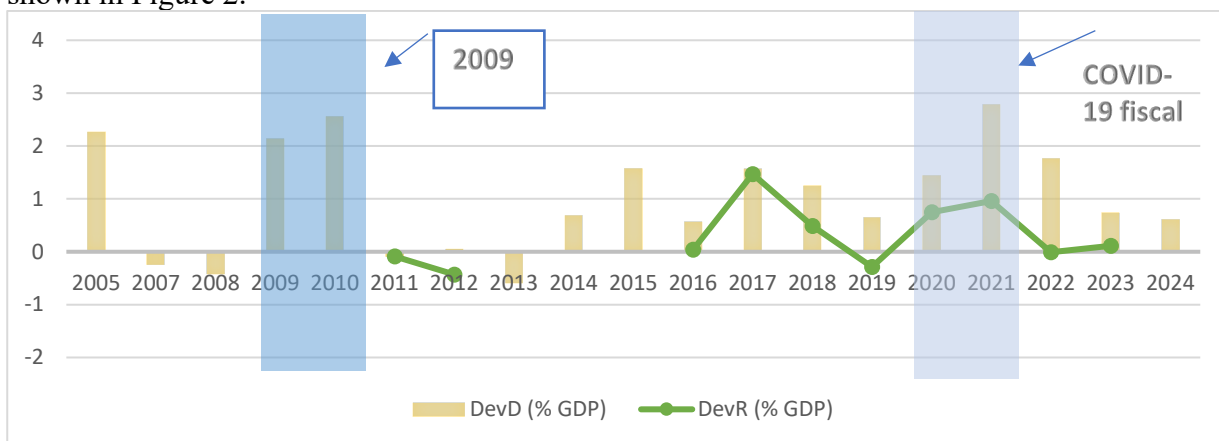


Figure 2. Deviations from Fiscal Targets: DevD and DevR, Republic of Moldova, 2005–2024

Source: Authors' calculations based on MF RM annual budget execution reports.

Correlation Analysis

The correlation matrix provides a first indication of how the main variables are related before turning to the regression estimates. As shown in Table 2, revenue volatility is positively associated with deficit execution deviations in both Pearson and Spearman terms. The Pearson coefficient remains below conventional significance thresholds, whereas the Spearman coefficient is somewhat stronger

and reaches significance at the 10 per cent level. This difference suggests that the relationship is more clearly monotonic than strictly linear and offers an initial indication that higher revenue volatility tends to coincide with larger deviations in deficit execution.

The relationship between revenue concentration and DevD is much weaker. Both correlation coefficients are close to zero, which points to the absence of a clear bivariate association over the period examined. By contrast, the interaction term combining volatility and concentration displays a stronger positive relationship with deficit execution deviations, particularly in rank terms. This result does not by itself establish a stable joint effect, but it suggests that the two revenue-side characteristics may become more relevant when considered together than when treated separately.

Table 2. Correlation Matrix (N=17, 2008–2024)

	VolR ₃	HHI	VolR ₃ ×HHI	DevD
VolR ₃	1.000	0.543**	0.970***	0.397
HHI	[0.108]	1.000	0.710***	0.003
VolR ₃ ×HHI	[0.961***]	[0.257]	1.000	0.351
DevD	[0.458*]	[0.042]	[0.520**]	1.000

Source: Authors' calculations. Pearson r — upper triangle; Spearman ρ in brackets — lower triangle. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

At the same time, the matrix reveals relatively strong associations among the explanatory variables themselves, especially between VolR₃ and the interaction term, and to a lesser extent between VolR₃ and HHI. This pattern is analytically important because it already points to the possibility of multicollinearity in the subsequent regressions. For that reason, the correlation analysis is best interpreted as an exploratory step: it helps clarify the direction and broad structure of the relationships, but it does not yet allow firm conclusions regarding their individual contribution to deficit execution deviations. The corresponding coefficients are reported in Table 2.

Regression Results

The regression estimates refine the patterns already visible in the descriptive and correlational analysis. Table 3 reports five OLS (Ordinary Least Squares) specifications estimated with Newey–West heteroskedasticity and autocorrelation consistent standard errors. In the baseline model, revenue volatility enters with a positive and statistically significant coefficient, indicating that higher volatility is associated with larger deficit execution deviations. The coefficient remains positive and significant when revenue concentration is added as an additional regressor, which suggests that the link between volatility and fiscal execution instability is not merely a bivariate one.

The picture becomes less clear once the interaction term is introduced. In these specifications, the coefficient on revenue volatility loses significance and changes sign, while the interaction term remains positive but statistically fragile. This shift is best read in connection with the strong association among the explanatory variables already noted in the correlation matrix. In a small sample, where the regressors overlap to a considerable extent, it becomes difficult to isolate their separate effects with precision. For that reason, the loss of significance should not be read too quickly as evidence of no relationship.

A more persistent result concerns revenue concentration. In the multivariate specifications, the HHI (Herfindahl–Hirschman Index) coefficient is consistently negative and statistically significant, which runs against the expected sign. This finding should be interpreted cautiously. Rather than pointing to a straightforward mitigating effect of concentration, it is more likely to reflect the structure of the sample itself, including the contrast between the pre-2013 period of higher concentration and relatively favourable deficit deviations, and the post-2013 period of lower concentration combined with a different fiscal and reporting environment. In this sense, the coefficient appears to capture not only differences in revenue structure, but also the influence of a period marked by methodological discontinuity and changing macro-fiscal conditions.

Table 3. OLS Regression Results — Dependent Variable: DevD (% of GDP), 2008–2024 (N=17)

	M1	M2	M3	M4	M5
<i>Dep. var.: DevD</i>	<i>H1 baseline</i>	<i>+HHI</i>	<i>+Interaction</i>	<i>+gPIB</i>	<i>+D2013</i>
Constant	+0.0037 (0.0037)	+0.0168 (0.0113)	+0.0432** (0.0157)	+0.0496*** (0.0127)	+0.0423*** (0.0106)
VolR₃	+0.0580* (0.0288)	+0.0820** (0.0341)	−0.1329 (0.2068)	−0.2090 (0.1719)	−0.0836 (0.1535)
HHI	—	−0.0382 (0.0270)	−0.0966** (0.0324)	−0.1153*** (0.0248)	−0.1005*** (0.0211)
VolR₃×HHI	—	—	+0.4452 (0.3875)	+0.6002* (0.3214)	+0.3676 (0.3041)
gPIB	—	—	—	+0.0212 (0.0237)	+0.0187 (0.0232)
D2013	—	—	—	—	−0.0200*** (0.0037)
R²	0.158	0.222	0.260	0.279	0.498
Adj. R²	0.102	0.111	0.090	0.039	0.270
Durbin–Watson	1.336	1.457	1.682	1.739	1.929

Source: Authors' calculations. Newey–West HAC SE (maxlags=2) in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. D2013 = structural break dummy (revenue reclassification 2013).

The interaction term remains positive across specifications, which is broadly in line with the view that volatility and concentration may reinforce one another. Even so, the result is not sufficiently stable to support a strong conclusion, since significance appears only in one specification and does not carry over to the robustness checks discussed below. Overall, the regression results suggest that revenue volatility has the clearest association with deficit execution deviations in the more parsimonious models, while the role of concentration remains more sensitive to model structure and to the particular features of the sample. The estimated coefficients are reported in Table 3.

Robustness Tests and Diagnostics

The regression results were further examined through a set of robustness checks designed to assess their stability under alternative specifications. Replacing the three-year volatility measure with a five-year rolling indicator weakens the estimated relationships, as the coefficients lose statistical significance. This outcome is not surprising given the further reduction in sample size and the smoother profile of the longer-window measure, which absorbs part of the short-term variation captured in the baseline models.

A more informative pattern emerges when potentially disruptive years are excluded from the analysis. When 2013 is removed, the coefficient on revenue concentration remains negative and statistically significant, while the volatility and interaction terms are no longer significant. A similar result is obtained when 2020 is excluded. Taken together, these checks suggest that the negative association between concentration and deficit execution deviations is more stable than the corresponding estimates for volatility or for the interaction term, although its interpretation remains constrained by the structural characteristics of the sample.

The lagged specifications provide little additional support for delayed effects, as none of the coefficients remains statistically significant. This points to a relationship that appears more contemporaneous than lagged, at least within the limits of the annual data used here. The diagnostic tests are broadly reassuring. Residual autocorrelation does not emerge as a major concern, the White test does not indicate significant heteroskedasticity, and most variables satisfy standard stationarity conditions. The main exception is VolR₃, which appears only borderline stationary, a result that is not unusual for rolling volatility measures in short samples. For this reason, the diagnostic evidence should be read as supportive but not definitive. Overall, the robustness analysis reinforces the view that the results are informative, though more suggestive than conclusive.

Conclusions

This article examined the relationship between fiscal revenue volatility, revenue concentration and budgetary risk in the Republic of Moldova over the period 2005–2024. Based on annual State Budget data, the analysis combined descriptive evidence, correlation analysis and OLS regressions with Newey–West standard errors to assess whether instability in the revenue base is reflected in deficit execution deviations.

The results indicate a clearer role for revenue volatility than for revenue concentration. In the more parsimonious specifications, higher revenue volatility is associated with larger deficit execution deviations, which suggests that unstable revenue dynamics may complicate fiscal execution. The evidence for revenue concentration is less straightforward. Contrary to the initial expectation, the HHI coefficient is negative and statistically significant in the multivariate regressions. This outcome appears to be closely linked to the structure of the Moldovan data, especially the difference between the pre-2013 and post-2013 periods and the break in revenue classification. The interaction between volatility and concentration remains positive, but its statistical support is not stable enough to justify a strong conclusion.

The findings also reflect several limits of the analysis. The effective sample is small, the revenue series is affected by a methodological discontinuity after 2013, and planned revenue data are not available for the whole period. These constraints reduce the possibility of testing revenue execution deviations over the full sample and limit the strength of the econometric conclusions. The models also do not include institutional or political factors that may influence budget execution.

Overall, the results show that revenue diversification, although important, is not sufficient by itself to reduce budgetary risk. For the Republic of Moldova, the more relevant issue seems to be the combination of revenue instability, forecast accuracy and continuity in fiscal reporting. This interpretation is consistent with public financial management approaches that link budget credibility to fiscal planning, execution control, revenue forecasting and explicit monitoring of fiscal risks (MEFMI, 2023). In this sense, budgetary risk depends not only on the composition of revenues, but also on the quality of planning and on the institutional capacity to monitor deviations during execution.

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SUSTAINABILITY AND CORPORATE GOVERNANCE IN THE CONTEXT OF AGENDA 2030: A BIBLIOMETRIC SYSTEMATIC REVIEW.

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Abstract: *The United Nations adopted the 2030 Agenda, bringing the concept of sustainability into the global economic discourse. Thus, the concept of sustainability and ESG metrics has become essential in corporate development strategies. The current research performs a bibliometric study of scientific publications dated from 2015 to 2026, with the aim of highlighting the evolution and the main trends and directions of development in the field. The study relies on a set of 9,460 documents indexed in the Web of Science database. Data analysis was conducted using the Bibliometrix software package (Biblioshiny interface), applying techniques for analyzing scientific output, thematic evolution, and strategic keyword mapping. The findings demonstrate an exponential growth in scientific production beginning in the 2021–2022 period. The research shows the high level of academic interest in general notion of social responsibility, its technical aspects, and quantifiable indicators, with reference to ESG performance, ESG scores, or risk. The study proves that the sustainability research field is gradually matured, and its key factors include the development of performance metrics. The study provides a reference framework for economic stakeholders as well as the academic community, emphasizing that the 2030 Agenda has succeeded in transforming sustainability from an ethical choice for companies into a measurable strategic objective.*

Keywords: *ESG, corporate governance, sustainability, Agenda 2030*

JEL: G32, G34, Q01, Q56

Introduction

Sustainability became a concept extensively analysed and discussed in the academic literature. Since the beginning of the century, the concept of sustainability has been examined from various perspectives, and the impact of integrating this concept into corporate governance is interpreted in different ways, as research indicates all sorts of impacts on governance.

The evolution of the concept of sustainability is complex and long-term, with different perceptions based on regional contexts. The relevance of the concept of sustainability starts from historical evolution and continues in its alignment with future global objectives.

The integration of sustainability into corporate governance is a timely topic that is rapidly evolving in the academic literature. The premise for this evolution was the international adoption of the 2030 Agenda for a sustainable future for future generations. An analysis of the specialized literature allows for an understanding of the main concepts identified, such as sustainability, corporate social responsibility, ESG factors, performance, and scores. This paper aims to highlight the main concepts by analyzing their temporal evolution and scientific output, identifying the intellectual pillars and foundational perspectives, as well as mapping the thematic landscape and detecting emerging trends to identify future research directions. For it, 9,406 articles were selected to meet the objectives, based on predefined criteria from the Web of Science database for the period 2015–2026, and the analysis was conducted using the Biblioshiny software, a tool integrated into R Studio. The study offers a synthetic perspective useful to both researchers and economic decision-makers, facilitating an understanding of the trajectory of sustainability from a theoretical concept to a strategic imperative at the national, regional, and international levels.

The paper continues with a brief literature review and continues in the third section with the bibliometric analysis of the recent scientific literature focused on the topics of ESG, SDG and corporate governance. Conclusions are highlighted in the fourth section of the paper.

Literature review

The concept of sustainability has gone through a series of phases, which have shaped its meaning. Thus, the first phase is the philanthropic one, marked by the introduction of the concept of social responsibility, which signifies a voluntary commitment by the business community. This commitment effectively helps alleviate economic problems and fully achieve economic goals. This phase also emphasizes the relationship between the state and the business community, through the government, which become partners in achieving public objectives (Bowen, 1953).

The second phase in the evolution of the concept of sustainability is the strategic phase, characteristic of the late 20th century, which gave rise to stakeholder theory and the triple bottom line theory, both of which emphasize the concept of stakeholders. Managers are directly responsible for implementing processes that would satisfy all stakeholders' needs, particularly those with a stake in the business. This has led to corporate social responsibility being viewed as a luxury add-on. The literature highlights the causal relationship between corporate social performance and financial performance, with studies from the late 20th century demonstrating that firms with high levels of corporate social performance experience an increase in the number of investors (Graves & Waddock, 1994). Furthermore, Elkington (1997) defines sustainability as the present actions of society being guided by principles that do not limit economic, social, and environmental options for future generations. Similarly, sustainability is defined from a corporate perspective in Elkington's view along three lines: social, economic, and environmental, explaining that society depends on the economy, and the economy in turn depends on the global ecosystem, with the environment considered the baseline.

The third phase is considered the financial integration phase, where unlike the earlier phases, in which corporate social responsibility lacked a comprehensive measurement method, this phase offers the possibility of quantifying the concept of sustainability through the introduction of ESG factors (Economic, Social, and Governance) according to the 2004 UN report. The UN report offers the same perspective regarding successful investments, which depend on a vibrant economy, a healthy civil society, and a sustainable planet. The effective integration of ESG factors into investment decisions contributes to more stable and predictable markets, which is in the interest of all stakeholders. The inclusion of ESG factors in financial reporting is also extremely important for emerging economies, which will gain ground in delivering sustainable economic growth and attracting investors seeking to diversify their portfolios. Similarly, transparency and disclosure are key to the synergy between ESG factors and financial reporting, and the number of companies reporting both qualitatively and quantitatively has increased significantly, from approximately 45% of the top 500 companies by revenue in 2004, when the term ESG was first introduced, and by 2024, this figure had risen to 96% (KPMG 2004, 2024).

The last and most recent stage of evolution is the regulatory stage, which pertains to the global standardization of sustainability disclosure and reporting. The problem of sustainability has been one of the main problems discussed at international organizations and governments for more than three decades. The concept of sustainability became institutionalized in the framework of the United Nations Framework Convention on Climate Change (UNFCCC), which set the basis for intergovernmental and corporate collaboration (UNFCCC, 1992). Later, this effort was complemented with the introduction of the Kyoto Protocol (1997), a landmark agreement that established mandatory emission reduction targets for industrialized countries.

In this regard, the European Union has introduced the EU ETS (Emissions Trading System), a market-based mechanism that caps emissions and allows for the trading of allowances granting the right to emit a limited quantity of greenhouse gases. The key development in global climate governance came with the Paris Agreement (2015). With the growing significance of transparency in business

operations, companies have progressively integrated ESG (Environmental, Social, Governance) factors since 2016. This trend was regulated by the EU Taxonomy, which standardized the reporting and classification of sustainable economic activities. The final framework was developed in 2019 in the form of the European Green Deal, which charted the EU's roadmap toward climate neutrality. An important boost came from the United States' re-entry into the Paris Agreement in 2020. In 2021, the financial sector aligned with these goals through the Net Zero Asset Owner Alliance, reinforcing the intrinsic link between investment decisions and sustainability.

The medium-term forecast (2023–2025) will be marked by the development of international policies aimed at the decarbonization of industries. This includes the full implementation of ESG regulations and new initiatives, such as the Clean Industrial Deal, which primarily target heavy industry and the energy sector. These policies are an addition to the existing program, named "Fit for 55" legislative package, which confirms the European Union's engagements to cutting down greenhouse gas emissions by at least 55% by 2030. Regulatory mechanisms entail the integration of global standards such as the Global Reporting Initiative and the Sustainability Accounting Standards Board. As a result, the first mechanism was adopted by the European Union and transposed into the Corporate Sustainability Reporting Directive (CSRD), adopted in 2022. The directive mandates mandatory sustainability reporting in the management report, as well as the audit of the sustainability report by an external auditor, which is mandatory for all large companies and those listed on the stock exchange. A preliminary review of the literature reveals that research focuses on the impact of sustainability integration at the microeconomic and macroeconomic levels. At the microeconomic level, studies examine the impact of integrating ESG factors, through various indicators such as ESG scores or proxy indicators like the implementation of environmental management systems, greenhouse gas emissions, energy efficiency, employment rates, and investments in education, on financial and economic performance, including profitability, sales growth, market share, or Tobin's Q.

Hence, companies with robust and transparent reporting, as well as high ESG scores, are viewed as less risky (Apergis et al., 2022 in Subhani et al., 2025) and are considered socially responsible investments. Furthermore, integrating sustainability strategies enhances financial performance, and strengthening the three pillars leads to greater economic efficiency for companies (Tomšič, N. et al., 2015). This is also confirmed in the research by Albuquerque et al. (2019), which posits that sustainability serves as a product differentiation tool when economic conditions deteriorate, where financial or systematic risk is associated with general market fluctuations that can affect a firm's value. Thus, the authors confirm that firms with high ESG scores have significantly lower systematic risk, because sustainability fosters consumer loyalty, thereby stabilizing profits during periods of economic crisis.

The integration of ESG factors has also become a crucial element in investors' decisions, as they, in turn, tend to evaluate companies' efforts in social activities. Sustainability can create value for investors by reducing uncertainty and risk in investment decision-making (Godfrey, 2009, in Landi et al., 2022). However, there is controversy surrounding the introduction of sustainability, with some researchers arguing that it serves as a means of destroying firm value (Hill, 2001 in Landi et al., 2022). Accordingly, investment risk increases because sustainability is viewed by investors as a band-aid to legitimize questionable business practices. If investors perceive the true intentions, they penalize companies on the stock market. Consequently, a commitment to sustainability can increase investors' uncertainty in decision-making (Jo & Na, 2012, in Landi et al., 2022).

At the macroeconomic level, efforts are geared toward examining the impact of sustainability at a national, regional, or even international level. In today's research, sustainability is primarily quantified by using the SDG index, a composite indicator that includes the 17 Sustainable Development Goals, while economic performance has been evaluated based on changes in GDP and foreign direct investment (FDI) flows. For example, Rapsikevičius et al. (2022), using panel regression, demonstrate that SDG implementation is conditioned by EU-specific social models:

capital freedom supports sustainability in the Eastern European model, but not in the Nordic one, with the relationship being mediated by institutional quality. Iwanicz-Drozdzowska et al. (2025), using dynamic GMM estimators, identify a pro-cyclical nature of sustainability in Europe, as ESG performance and economic growth are mutually reinforcing, with the governance (G) pillar exerting the strongest impact on GDP and validating the European model as a global leader in ESG standards. On the opposite, sustainability can also be measured by the Environmental Performance Index, and the study by Pata et al. (2025) highlights that the BRICS countries, as the primary contributors to a massive portion of global emissions. Accordingly, significant steps in adopting sustainability policies attract foreign investments, turning sustainability into a driver of economic growth. The study also demonstrates a long-term correlation between sustainability policies that would stimulate renewable energy and foreign investment, establishing a co-integration relationship that yields the greatest improvements in environmental and economic performance.

The key value of bibliometric analysis is that it serves as the validation of existing theoretical pillars, which forms a basis for theoretical studies in the future. Apart from laying the groundwork for theory development, literature review plays an important role in recognizing paradigm shifts and tracking trends, aiming to identify gaps for further investigations.

Bibliometric analysis

The academic literature on sustainability has exploded following the adoption of these principles at the international level and the 2015 Paris Conference. Since then, sustainability has been the central pillar of researchers' work, being directly linked to economic growth, financial performance, and institutional attractiveness. In this regard, the current bibliometric analysis research is set up for the following objectives:

- Analyzing the temporal evolution and scientific output from the adoption of the 2030 Agenda in 2015 to the present.
- To identify the intellectual pillars through the authors and seminal works in the field of sustainability.
- To map the thematic landscape to identify the abundance of research at the micro and macro levels.
- To detect emerging trends to identify current and less current research niches.

To achieve these objectives, the primary data source was the Web of Science (WoS) database, which is characterized by high-quality academic literature with real impact, as well as historical consistency that allows for analysis over long periods of time. The software used to identify and understand literature is Biblioshiny, an R package that enables everything from descriptive statistics to complex network analyses and conceptual structures.

The first step is to select the database to be processed using Biblioshiny, and the criteria are outlined in Figure 1. We selected the papers with topics related to ESG or SDG and corporate governance. Upon importing the 9,406 results from WoS, the Biblioshiny software identified the following: 1,660 sources, with 31,853 authors (including 620 individual authors), 17,789 keywords, and 276,554 citations.

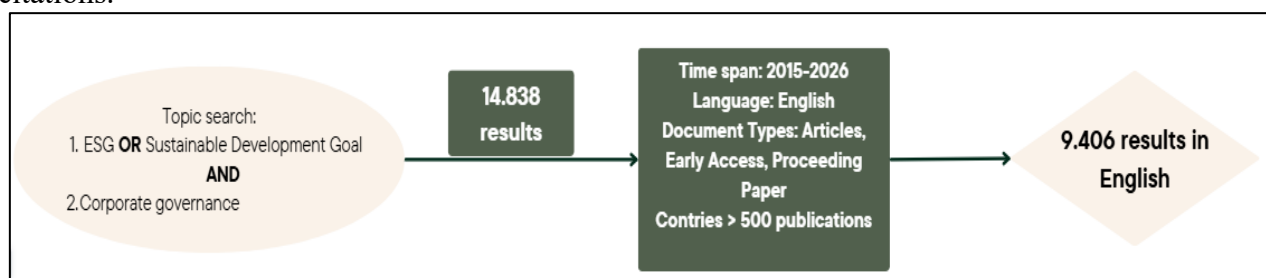


Figure 1. Filtering the results obtained from WOS

Source: compiled by the author

The software also provided the ability to view annual scientific output, as shown in Figure 2. As a result, the selected analysis period is from 2015 to the present, and the annual scientific output has been consistent but low since 2015, following the Paris Agreement. Starting in 2019, the output began to increase, driven by legislative factors, as the European Commission launched the European Green Deal, thereby transforming sustainability from a voluntary option into a legal obligation. Also, during this period, the introduction of the EU Taxonomy forced the academic and business communities to adopt activities that are truly considered sustainable according to taxonomy. The year 2019 marks the beginning of the COVID-19 pandemic, which has heightened the need for a resilient economy, as well as a focus not only on the environmental pillar (E) but also on the social (S) and governance (G) pillars. Consequently, 170 articles were published in 2019, and by 2025, more than 3,000 articles are projected, representing an increase of about 188%, with an annual growth of approximately 33%.

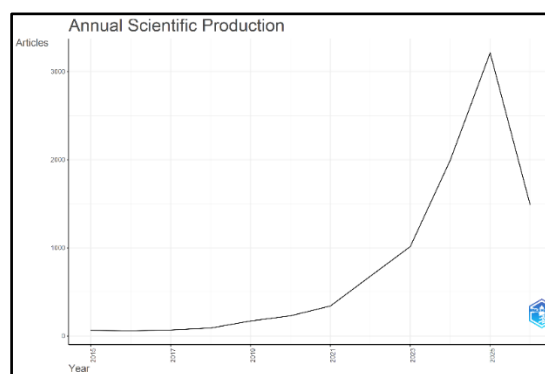


Figure 2. Annual Scientific Production obtained from WOS
Source: compiled by the author via Biblioshiny

The software also made it possible to identify the intellectual pillars through the authors and seminal works on sustainability, using a Sankey diagram, thereby illustrating the relationship between the most frequently cited references, the most active authors in the dataset, and relevant keywords. Therefore, we identify from Figure 3 key references such as the study by Dhaliwal et al. (2011), which confirms that the reporting and disclosure of sustainability reports reduces information asymmetry between management and investors, enabling a detailed assessment of the firm's risk profile and leading to lower compliance costs. The strong presence of this article confirms the grounding of the 9,000 articles in classical financial and management theories. Also, in second place is the study by Cheng et al. (2014), a study relevant to ESG scores, which highlights that companies with high scores face fewer barriers in accessing financing, as they are viewed as less risky due to high transparency, reduced agency risk, and alignment with long-term stakeholders. This is also confirmed by the presence of Freeman's (1984) stakeholder theory in the dataset, serving as the supreme theoretical pillar for ESG. Furthermore, the current thought leaders in the field of sustainability are authors Hussainey, Tsang, and Uyar, from whom strong connections originate, underscoring their relevance and importance.

problematic. Therefore, the authors demonstrate that rating agencies provide different ESG scores for the same companies. Conversely, Broadstock's (2021) research emphasizes that portfolios with high ESG scores were more resilient during the market crash caused by Covid-19 and in other periods of volatility, strengthening confidence in ESG scores contrary to Berg's (2022) research.

In order to create thematic maps, the most frequently used keywords in the specialized literature will be analyzed. As it can be seen in the figure, the thematic map is focused on the microeconomic environment. The words such as "ESG" (2,730 occurrences) and "corporate social responsibility" (1,678 occurrences) play a dominant role, marking the transformation from a philanthropic approach to one of reporting and measurement.

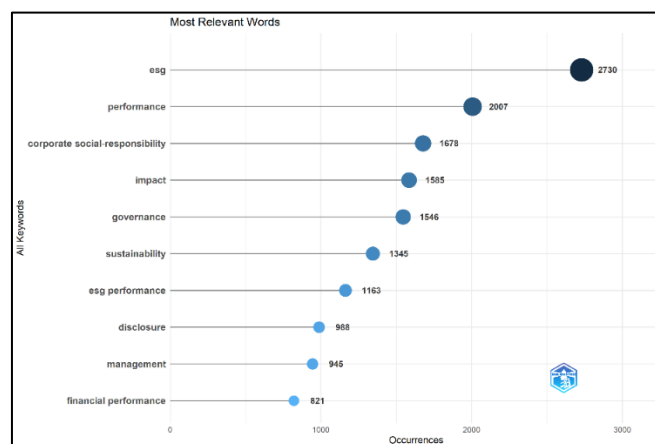


Figure 5. Most Frequent Words

Source: compiled by the author via Biblioshiny

Terms like "performance" and "financial performance" are also commonly used. This is because the academic interest is increasing to validate the hypothesis that integrating sustainability can drive financial and economic performance. The presence of terms such as "governance" denotes the integration of sustainability on a higher the macro level, specifically it acts as a link between impact and management—a trend particularly evident in the Asian region. This market has rigorous government regulations on sustainability and the mandatory requirement for companies to implement environmental governance practices.

The thematic map in Figure 6 clearly shows the polarization of the themes discussed in the study. The prominent cluster includes Corporate Social Responsibility, Impact, and Governance, thus proving the importance of the G pillar as the main driver of development in the indexed literature. The pink cluster, comprising the terms ESG, performance, and risk, hence, proves the thesis statement that sustainability is now viewed through the prism of financial pragmatism and resilience in the face of economic uncertainty. This demonstrates that integrating ESG strategies into corporate governance reduces the risk profile, making companies more attractive to investors, as confirmed by the research conducted by Subhani et al. (2025). Furthermore, the term "Innovation" is included in the green cluster, suggesting a link to social responsibility, which is essential in the context of sustainability. Emerging trends were recognized during the thematic evolution.

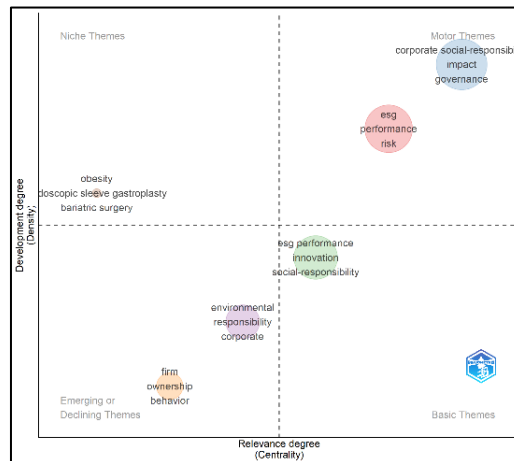


Figure 6. Thematic Map
 Source: compiled by the author via Biblioshiny

The thematic map highlights in Figure 6 a clear polarization in the research. The dominant cluster consists of Corporate Social Responsibility, Impact, and Governance, highlighting the importance of the G pillar as the primary driver of development in the indexed literature. The pink cluster, comprising the terms ESG, performance, and risk, also emerges as a driving theme, supporting the hypothesis that sustainability is now viewed through the lens of financial pragmatism and resilience in the face of economic uncertainty. This demonstrates that integrating ESG strategies into corporate governance reduces the risk profile, making companies more attractive to investors, as confirmed by the study by Subhani et al. (2025). Additionally, the word “Innovation” appears in the green cluster, suggesting a link to social responsibility, which is essential in the context of sustainability. Emerging trends were identified through thematic evolution.

For this analysis, a threshold was set in 2020, resulting in two important time spans, namely 2015 to 2020 (the post-adoption period of the 2030 Agenda) and the period 2021 to 2026 (the current period of accelerated implementation).

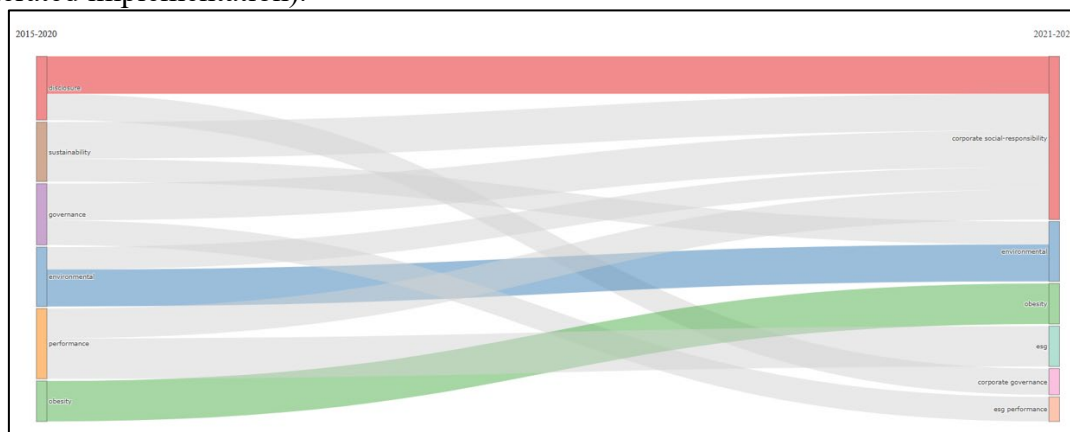


Figure 7. Thematic Evolution
 Source: compiled by the author via Biblioshiny

As indicated by Figure 7, the concept of “environmental” maintains a linear and constant trajectory between the two periods. This stability demonstrates that the environmental pillar remains a constant and unchanging priority in WoS literature, serving as a foundation for future studies. Similarly, the consolidation of the term “corporate social responsibility” is evident. Fundamental terms from the first period, such as “disclosure”, “sustainability”, and “governance”, converge heavily in the second period toward “corporate social responsibility”. An important branch extends from “performance” to

“ESG performance” and “ESG” (2021–2026), serving as clear evidence of a thematic shift from measuring performance, whether financial or economic, to the specific measurement of ESG performance. Thus, measurement and quantification become extremely relevant, with technical indicators taking priority.

Figure 8 demonstrates the trends emerging, revealing that the base period is from 2017 to 2021, wherein the social pillar becomes dominant, especially in medicine. The transition period takes place from 2021 to 2023 when sustainability starts being measured financially by discussing the investment opportunities in sustainable development through topics like ESG investments or portfolios that imply that sustainability impacts capital markets, and the research area moves from social pillars to economic ones. The contemporary period from 2023 to 2025 involves ESG technocracy and governance, where frequent topics include ESG, Performance, Innovation, and Corporate Social Responsibility (CSR). These topics incorporate other less frequent topics making the term "ESG" the norm. Some emerging areas include "Signaling" and "CSR Committee." "Signaling" can be considered an emerging niche due to the academic literature exploring whether ESG disclosure is a legitimate signal of the company's performance or just a form of greenwashing. “CSR Committee” is a more detailed form of the corporate governance pillar which focuses on internal organizational structures.

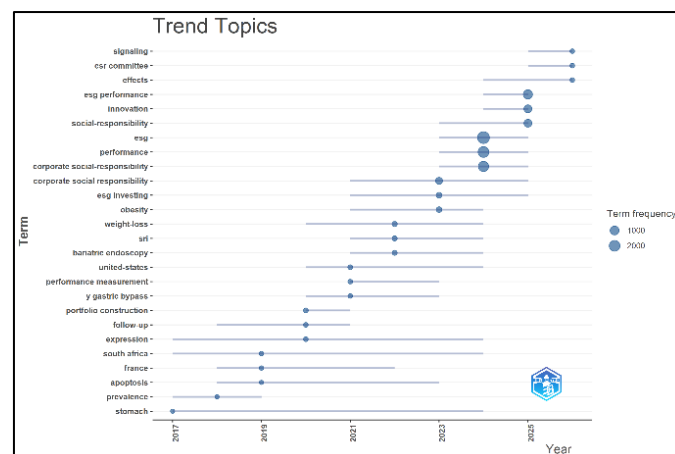


Figure 8. Trend Topics

Source: compiled by the author via Biblioshiny

The review of literature and bibliometric analysis helped confirm the validity of the initial research objectives. The fulfilment of the first objective was possible thanks to the discovery of an exponential growth of scientific production which is constantly accelerating and growing; this is a result of international motives which are being applied by institutions like the UN or the European Union through their directives. Moreover, the detection of the intellectual foundations of the domain has allowed concluding that the research carried out within the framework of sustainability continues to be based on theories of corporate governance, taking into consideration the microeconomic aspect rather than the macroeconomic one. It is proof that there is a shift in paradigms, since academics' interest has changed from discussing the theory to devising mechanisms for embedding sustainability in corporate governance by means of ESG, the rating agencies, and its effect on economic and financial performance, among others. It is evident that sustainability has become one of the key pillars of current business strategy.

Conclusions

The body of literature on sustainability continues to grow, with an organic development observed from 2015, following the Paris Agreement, to the present. There has been an increase in scientific

output and an evolution of core concepts, as well as the emergence of new concepts. Sustainability has evolved from the concept of corporate social responsibility, an act of goodwill and voluntary engagement, to a quantifiable concept that allows for performance measurement. Furthermore, while sustainability was characterized by a strong emphasis on the social pillar at the outset of the 2030 Agenda, the environmental and governance pillars are now central. Environmental initiatives adopted by companies provide them with a competitive edge and an attractive profile for all stakeholders. Integration of ESG aspects in corporate strategies reduces corporate risk, and innovation catalyzes this context. However, one of the main issues found in literature is related to the accuracy of ESG scores assigned by rating agencies. Empirical research supports the positive correlation between high ESG ratings and indicators such as market share, financial performance, and resilience during periods of economic volatility. Nevertheless, a critical dilemma persists in the literature regarding the validity and convergence of the metrics used to assess the consistency of these scores.

The main trend remains analysis at the microeconomic level rather than the macroeconomic level. Transparency in reporting remains the key element in research, even though many authors question whether voluntary disclosure is an act of honesty or a marketing ploy, and this line of research is a niche area that will soon gain ground. It is worth noting that the literature does not draw a clear geographical distinction between regions with higher or lower output of the studies in this field. The pioneers in research continue to refer to Asian countries, with strict government policies in the field of sustainability, while the European Union remains a pioneer in the legislative regulation of sustainability. In this regard, one research direction would be to clearly identify the countries that emphasize scientific output in the field of sustainability, a task complicated in this study due to the vast number of articles in the Web of Science. In this context, one of the possible future research directions might be to cluster countries according to their economic development, the implementation of governmental strategies, or legislation complexity. The future research should be directed at exploring the standardization of ESG indicators in order to fill the gaps mentioned in the critique of rating agencies' activities.

The limitations of this review can be attributed to the use of only the Web of Science database which prevents from seeing works published in other scientific databases. Another limitation might be associated with the period after 2015 when the term sustainability started to develop. In addition to this, there was a restriction in terms of selecting only English-language materials, which may not be representative of certain aspects.

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BETWEEN DATA AND GOVERNANCE: UNVEILING THEMES AND COLLABORATION IN DIGITAL GOVERNMENT LITERATURE

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Abstract: *Digital transformation has become a central driver of public administration modernization, as governments increasingly rely on digital technologies to improve public service delivery, administrative efficiency, transparency, and citizen-oriented governance. However, the rapid expansion of digital government research has generated a fragmented literature, dispersed across concepts such as e-government, digital transformation, public services, governance, innovation, and emerging technologies. This fragmentation limits the understanding of how the field is thematically structured and how scientific collaboration is organized across countries and institutions. Therefore, this paper maps the intellectual structure of digital government literature and identifies the dominant themes, emerging research directions, and collaboration patterns within this field. A bibliometric science-mapping analysis was conducted on 1,877 documents indexed in the Web of Science Core Collection, retrieved using the topic search terms "digital transformation" and "public services". The analysis was performed with VOSviewer and focused on keyword co-occurrence, country co-authorship, and organizational co-authorship networks. The findings show that digital transformation serves as the conceptual hub of the field, connecting traditional e-government research with newer themes in innovation, governance, artificial intelligence, big data, trust, adoption, performance, and post-pandemic public service resilience. The country-level network reveals broad but uneven international collaboration, while the organizational network remains more fragmented. The study contributes by integrating thematic and collaboration-based perspectives, showing that digital government research is expanding, interdisciplinary, and globally visible, but still institutionally fragmented and unevenly connected. These findings indicate the need for stronger institutional partnerships, interdisciplinary integration, and more coherent research networks in future digital government studies.*

Keywords: *digital government; digital transformation; public services; bibliometric analysis; VOSviewer; public administration.*

JEL: H83; O33; O38; L86.

Introduction

Digitalization of the government has become one of the leading forces behind change in modern public administration. Governments face growing demands to provide citizens with faster, more convenient, more transparent, and more adaptive public services. In this respect, digital government does not mean just digitizing existing government functions but rather entails a much broader transformation of governments.

The changing nature of digital government research can be seen by comparing early approaches that emphasized e-government, i.e., the application of ICTs to deliver public services. In contrast, recent research emphasizes digital transformation, which entails an even more profound process of transformation than what was seen before. For instance, Janowski (2015) notes that the process of digital government development entails digitization, transformation, engagement, and contextualization, while Mergel, Edelmann, and Haug (2019) indicate that digital transformation of governments encompasses administrative transformation across several dimensions beyond mere technology application.

Moreover, it has become more complex for the science. Modern scientific studies of digital government involve theories and approaches used in various areas, including public administration, information systems, management, innovation studies, public policy, and governance studies. Digital government transformation is considered in context with various issues such as service quality, efficiency of management and administration, transparency, trust, participation, innovative capacity, artificial intelligence, big data, and resilience after the pandemic era. Scientific knowledge keeps becoming more and more diversified; however, it has become extremely fragmented due to many concepts and scientific approaches.

Nevertheless, the emergence of studies dedicated to digital government has not been reflected in the creation of comprehensive and systematic overviews of literature on this topic that would reflect the development of thematic areas and scientific cooperation. Most studies concentrate on the process of concept formation and issues related to technology and management aspects, but little research is devoted to the interaction between thematic trends and scientific cooperation.

In this regard, bibliometric science mapping becomes quite important because it facilitates an analysis of extensive and scattered literature. Contrary to traditional methods of review, bibliometric analysis allows discovering latent intellectual structures, thematic groups, areas of research influence, and collaboration patterns between nations and institutions. In other words, this approach can be used to detect the conceptual structure and scientific connections underlying the research on digital government. According to Donthu et al. (2021), bibliometric analysis represents a robust approach to analyzing scientific literature in extensive volumes. Van Eck and Waltman (2010) demonstrate that VOSviewer is quite helpful in building bibliometric maps.

On the basis of this gap, the current study attempts to identify the structure of knowledge in the literature of digital government and its major themes, emerging trends, and collaboration patterns. It helps fill the identified gap in the literature since the current study offers a combined bibliometric approach that addresses both thematic and multi-level collaboration patterns at once.

To guide the analysis, the study addresses the following research questions:

RQ1: What are the dominant and emerging research themes in digital government literature?

RQ2: How are collaboration patterns structured at the country and organizational levels?

RQ3: What relationships can be identified between thematic development and collaboration networks?

The article is structured as follows. The next section presents the data and methodology, including the search strategy, selection criteria, and VOSviewer thresholds. The third section discusses the bibliometric results, focusing on keyword co-occurrence, country co-authorship, and organizational co-authorship. The final section summarizes the main findings, highlights the study's limitations, and outlines future research directions.

Basic content

In this section, the aim is to operationalize the research objective by identifying the intellectual and collaborative structure of the literature on digital government. Based on the research questions posed at the introduction stage, the analysis is conducted along three different but complementary dimensions, including keywords co-occurrence, which represents the thematic structure; country co-authorship, reflecting collaboration at the international level; and organization co-authorship, depicting the structure of the scientific production process.

The bibliometric study was carried out by processing the information obtained from the Web of Science Core Collection database. The topic search "digital transformation" AND "public services" was used, yielding 1,877 publications. The analyzed collection spans the period from 1997 to 2026 and was extracted on 03.05.2026. There were no filters applied to document type, as the objective of the study is to analyze the intellectual and collaboration networks based on Web of Science. In fact, topic search allowed us to find papers in which these topics appeared in the title, abstract, author keywords, or Keywords Plus. Topic search was selected for the research because it encompasses a broad scientific area at the intersection of digital transformation, public administration, and the provision of public services.

Before conducting any bibliometric analysis, it was necessary to check and clean the exported metadata to improve the reliability and consistency of the study's findings. In particular, such data-cleaning activities included searching for spelling differences, identifying equivalent terms, and filtering generic/weakly informative terms that do not aid understanding of the field's structure. This activity was especially important for keyword analysis, as there might be variations in similar concepts, and for co-authorship analysis due to variations in institutional/country names in Web of Science records.

VOSviewer was used to analyze bibliographic data and construct bibliometric maps across various dimensions. In particular, three dimensions-keyword co-occurrences, co-authors' country, and organization, were explored in the study. These dimensions of bibliometric analysis were chosen for their relevance to the study's purpose.

For keyword co-occurrence analysis, the minimum number of occurrences of a keyword was set at 50. Out of 6,624 keywords identified in the dataset, 28 met the threshold and were included in the final map. For country co-authorship analysis, the minimum number of documents per country was set to 25, and the minimum number of citations was set to 1. Out of 114 countries, 31 met these thresholds. For organizational co-authorship analysis, the minimum number of documents per organization was set to 10, and the minimum number of citations was set to 1. Out of 2,491 organizations, 17 met the thresholds.

The selected thresholds represent an optimal compromise between analytical clarity and representation. A more conservative choice of threshold would result in maps that are too detailed and therefore hard to understand. Conversely, choosing a more liberal threshold would be tantamount to omitting actors and issues that need to be considered in the analysis. Hence, the chosen thresholds ensure the visibility of the most prominent actors and keywords.

Table 1. Bibliometric search protocol and VOSviewer thresholds

Element	Description
Database	Web of Science Core Collection
Period covered	1997-2026
Extraction date	03.05.2026
Document types	No additional filter was applied regarding document type.
Search query	"digital transformation" AND "public services"
Search field	Topic

Element	Description
Initial results	1,877 documents
Software	VOSviewer
Keyword co-occurrence threshold	Minimum 50 occurrences; 28 of 6,624 keywords included
Country co-authorship threshold	Minimum 25 documents and 1 citation; 31 of 114 countries included
Organization co-authorship threshold	Minimum 10 documents and 1 citation; 17 of 2,491 organizations included

Source: Author's processing based on Web of Science Core Collection and VOSviewer outputs.

Level one of analysis answers RQ1 by analyzing the theme structures of DG studies using the keywords' co-occurrence technique. Figure 1 not only presents the top 10 most frequently used terms but also shows the linkages and clustering of concepts in the DG area. It shows that there is indeed an existing core concept in the field, with “digital transformation” as the central theme that links the conventional area of e-government studies to new areas such as innovation, governance, artificial intelligence, trust, performance, and the modernization of public services.



Figure 1. Keyword co-occurrence network in digital transformation and public services literature

Source: Author's processing in VOSviewer based on Web of Science Core Collection data.

The most visible term in the network is “digital transformation”, with 541 occurrences and a total link strength of 873. This clearly shows that digital transformation acts as the primary organizing principle in the studied body of literature. Second to digital transformation is the term “e-government” with 242 mentions and a cumulative link strength of 557, indicating that the field of study is closely associated with the conventional literature on electronic government services. Other central terms include “innovation”, “management”, “digitalization”, “technology”, “governance”, “transformation”, “government”, “digital government”, “artificial intelligence”, “information”, “services”, and “public administration”.

Positioning “digital transformation” and “e-government” in the network reveals that research on the issue relies on a transition from traditional approaches to e-government towards digital government approaches. In other words, e-government can be considered a phenomenon implying the use of digital technologies in rendering public administration services through the Internet. In its turn, digital

transformation refers to more profound transformation of public administration processes as regards the possibility of delivering public value. This implies that according to bibliometric analysis, the field of digital government does not overlook the problem of e-government.

A second important thematic area is represented by the terms "innovation", "management", "governance", "framework", and "challenges". These keywords show that researchers are interested not only in the adoption of technologies, but also in the managerial and institutional conditions that enable or constrain digital transformation. This direction is particularly relevant for public administration because technological modernization depends on administrative capacity, leadership, organizational flexibility, regulatory adaptation, and the ability to coordinate complex digital projects across institutions.

The third thematic category can be attributed to technological advancement. Terms such as "artificial intelligence," "big data," "ICT," "internet," "technology," and "digital economy" underscore the growing significance of technological advancements in shaping the future of public service provision. Artificial intelligence stands out as one of the most prominent terms, implying that contemporary literature pays close attention to automated decision-making, prediction, intelligent service delivery, chatbots, and algorithmic governance.

The fourth theme deals with public service impacts and citizen-centered aspects. Terms such as "public services," "services," "performance," "trust," "adoption," and "impact" suggest that the literature is now drawing connections between digital transformation and the creation of public value. It is significant because digital technology does not necessarily enhance public administration; its significance lies in whether it increases accessibility, simplifies processes, enhances service delivery quality, builds trust, and makes a difference in public sector performance.

In addition, the presence of "COVID-19" on the map is another indicator of the development of post-pandemic research. The pandemic created a need for remote public service delivery, citizen-institution communication, and robust administrative infrastructure. While the total link strength associated with "COVID-19" is lower than that of more conventional terms such as digital transformation, e-government, and governance, the term's inclusion in the map reveals its integration into the research landscape.

Table 2. Compact synthesis of the main bibliometric groups

Dimension	Main groups identified in the dataset
Very high-frequency keywords	Digital transformation; e-government; innovation
High-frequency keywords	Management; digitalization; technology; governance; transformation; government
Public administration and service keywords	Digital government; public administration; public sector; public services; services; performance; trust; adoption; impact
Technology-oriented keywords	Artificial intelligence; big data; ICT; internet; digital economy
Countries with more than 100 documents	China; England; Russia; United States; Italy; Spain
Countries with 75–99 documents	Germany; Brazil; Australia
Countries with 50–74 documents	India; Romania; Ukraine; Greece; Indonesia

Dimension	Main groups identified in the dataset
Most visible organizations by documents	Bucharest University of Economic Studies; National Economic University; University of Brasilia; Russian Academy of Sciences; Delft University of Technology; University of Seville

Source: Author's processing based on VOSviewer outputs.

The pattern implies that digital government studies are transitioning from a purely technological view of electronic service delivery to a more institutional/governance view. This means that the study of digital government is no longer organized solely in terms of digitalizing services but in terms of transforming public administrations, creating public value, and integrating new technologies in governance.

The second order of analysis addresses RQ2 by examining the structure of international cooperation at the national level. As Figure 2 depicts, while the field has broad global coverage, international scientific cooperation is not evenly distributed across the world map. Instead, many clusters indicate that digital government studies are affected by both geographical proximity and academic specialization. The countries included in the visualization are those that exceeded the criteria of having at least 25 documents and citations. It is possible to observe the density of the graph, which proves that the topics under study have attracted researchers worldwide. Nevertheless, there are still many inequalities present in the field.

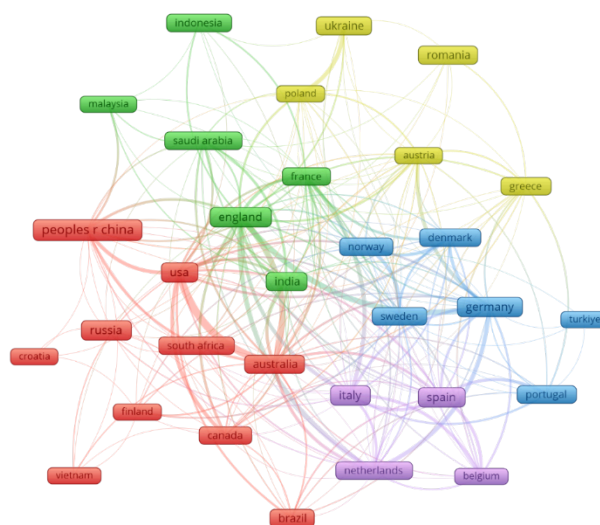


Figure 2. Country co-authorship network in digital transformation and public services literature

Source: Author's processing in VOSviewer based on Web of Science Core Collection data.

Regarding the production of scientific literature, the leading nation in the study is China, with 176 publications. England and Russia follow these, each having 120 papers; the United States with 119; Italy with 112; Spain with 109; Germany with 97; Brazil, Australia, India, Romania, Ukraine, Greece, Indonesia, Portugal, Sweden, the Netherlands, France, Canada, and Norway. From these numbers, we can see that the literature on the topic under study originates not only from Western academic circles but also from other continents and regions.

The citation structure portrays an alternative picture. Germany leads the list with respect to the number of citations, recording 2,438 citations, followed closely by China, which records 2,436 citations. This is followed by the United States, which records 2,192 citations; England, with 2,064 citations; Italy, with 1,727 citations; Austria, with 1,394 citations; Spain, with 1,240 citations;

Denmark, with 1,136 citations; Australia, with 1,052 citations; and Norway, with 818 citations. It is evident from the findings that certain countries are productive and at the same time cited.

Total link strength demonstrates the level of cooperation. England demonstrates the largest total link strength with 107, while Australia has 88, the US has 84, Germany has 77, Italy has 63, the Netherlands has 59, Spain has 58, France has 56, Austria and India have 44, and China has 43. Thus, these numbers suggest that productivity and cooperation may be distinct concepts. While China ranks first in productivity, England is a leading nation in network collaboration. Moreover, although Australia has fewer publications than China, England, the US, Italy, and Spain, it has a high total link strength.

The map provides insights into several collaboration groups. Firstly, the map groups China, the USA, Australia, Canada, Brazil, Russia, and South Africa together. Secondly, there is a clear group comprising countries such as Germany, Denmark, Norway, Sweden, Portugal, and Türkiye. Thirdly, a cluster including Italy, Spain, the Netherlands, and Belgium has been identified, and yet another group comprises countries such as England, France, India, Saudi Arabia, Malaysia, and Indonesia. Collaboration does not just depend on geographical proximity but is also affected by academic affiliation.

Romania's contribution to the network is based on 65 papers, 309 references, and an aggregate strength of 8 connections. The position of Romania in the network indicates the participation of Romania in the scientific discourse; however, the international co-authorship intensity of Romania is relatively low. This finding may be perceived as a motivation for future research, which should imply greater involvement in international projects and comparative research on digital public services and public sector modernization.

It can be concluded from the country-level visualization map that scientific leadership and network centrality do not coincide to some extent. For instance, China is one of the countries characterized by high productivity, whereas countries such as England and Australia are more central in terms of collaboration density. It is essential to note that influence in science is not measured solely by the number of publications, but it also reflects the ability to integrate different research communities of different countries into one network.

Finally, it can be seen that the collaboration map among countries reveals the existence of an international distribution but unequal integration of scientific studies devoted to digital government. Only a few countries become key players in cooperation with one another, whereas other countries play a peripheral role in joint authorship. Further research on the topic might involve more countries from Eastern Europe, Southeast Europe, Latin America, Africa, and Asia.

Level three of the analysis builds on the previous research question (RQ2) in that it extends the analysis from an examination of countries to an examination of organizations. It can be observed from Fig. 3 that a new structure emerges when comparing the map from the country perspective with that of the organization. Although collaboration is quite dense among countries, it is not very coherent among organizations, with fewer strong ties among institutions.

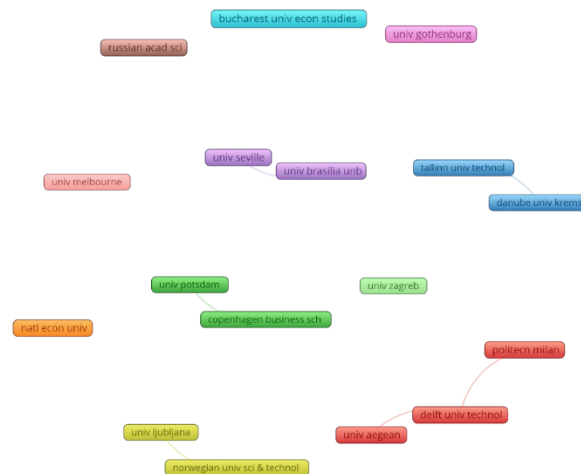


Figure 3. Organizational co-authorship network in digital transformation and public services literature

Source: Author's processing in VOSviewer based on Web of Science Core Collection data.

From the organizational map above, one can deduce that, despite the visibility and thematic consistency of digital government studies across the globe, the organizational structures are not well-connected. Therefore, in addition to efforts to increase the number of studies conducted and published, there should be a greater focus on institutional connections and collaborations.

The organization publishing the highest number of articles is Bucharest University of Economic Studies, with 21 papers. The other institutions following are the National Economic University, the University of Brasilia, and the Russian Academy of Sciences, each having 13 papers. Others with 12 papers each include Delft University of Technology and the University of Seville. Other institutions with 11 papers each include the Polytechnic University of Milan, the University of Aegean, and the University of Gothenburg. There are several institutions with 10 publications each, including Copenhagen Business School, Danube University Krems, Tallinn University of Technology, Norwegian University of Science and Technology, University of Ljubljana, University of Melbourne, University of Potsdam, and University of Zagreb.

In terms of citation impact, Danube University Krems stands out with 1,098 citations, despite having only 10 documents. This suggests the presence of highly influential publications associated with this institution. National Economic University follows with 528 citations, while Polytechnic University of Milan records 417 citations, Copenhagen Business School 308 citations, Delft University of Technology 291 citations, and University of Potsdam 257 citations.

But the total strength of links is usually quite low. The highest total strength of links is observed at Delft University of Technology, which totals 2. All other institutions have a total link strength of either 0 or 1. It is, therefore, clear that the organization's authorship network is not very strong.

This finding is relevant because it shows a difference between country-level and organization-level collaboration. At the country level, the network appears dense and internationally connected. At the organizational level, however, the network is dispersed into small components, with many isolated or weakly connected institutions. This may be explained by the interdisciplinary nature of digital government research, which is often produced by researchers affiliated with different departments, such as public administration, management, information systems, economics, political science, or urban studies. It may also suggest that international collaboration often occurs through individual academic relationships rather than through stable institutional consortia.

The map of organizations is informative regarding the presence of European institutions within the research area under study. The list of visible contributors includes organizations from Romania, Austria, Denmark, the Netherlands, Italy, Spain, Sweden, Estonia, Slovenia, Croatia, and Norway,

among others. In this sense, it can be assumed that European academic institutions make significant contributions to the study of digital transformation in public services. However, the network's fragmented nature suggests that institutional collaboration would be useful for its further development.

Taken together, the three bibliometric maps demonstrate that the thematic evolution of digital government research appears more consistent than its collaboration networks. The keyword map shows a dense set of keywords built around digital transformation, e-government, governance, innovation, and public service provision. At the same time, the map of country collaborations suggests an extensive and rather dense international network that nevertheless exhibits uneven geographical distribution, with developed countries more heavily represented than countries at a peripheral stage of development. However, the organizational collaboration map shows no signs of consistency, as international collaboration occurs primarily through individual scholars and their national connections.

Conclusions

This paper mapped the thematic structure and collaboration patterns of digital government literature, based on 1,877 documents indexed in the Web of Science Core Collection and analyzed through VOSviewer. The results indicate that digital transformation is more than just another subject area; it is actually the conceptual center of the domain, linking past e-government studies to new trends in governance, innovation, technology, trust, adoption, performance, and public service modernization. The outcomes of keyword co-occurrences reflect an evident change from e-government to digital transformation. This fact implies that the subject in question is no longer confined to offering government services through technological means but focuses on organization transformation, adaptation of governance instruments, and value generation through governmental projects. These outcomes are indicative of growing interdisciplinarity in the subject matter and the involvement of views and methods of such disciplines as public administration, information systems, management, governance, and innovation studies. Moreover, evident growth in such topics as artificial intelligence, big data, COVID-19, trust, adoption, and performance is observed.

The results from the analysis of the collaboration reveal an important structural inequality that exists within the subject area. For example, while the subject area is internationally recognized due to a number of participating countries, there is a clear discrepancy between productive and central collaboration. Although countries like China generate numerous publications, other countries like England seem more central within the subject area when it comes to collaboration. It is important to recognize that scientific dominance includes collaboration among countries.

The structural distinction between the maps of country and organization represents an important discovery. While there seems to exist relatively higher levels of collaboration among countries, collaboration within organizations is still divided and lacking any strong institutional connection. Thus, even though there exists worldwide recognition of digital government research, its integration is poor and the motivation to collaborate depends more on the initiatives of individual researchers rather than institutional connections.

The limitations of the study are inherent to the use of the Web of Science Core Collection, selected keywords, and VOSviewer thresholds that can potentially fail to include some relevant or emerging contributions. The future studies in this area can be focused on the analysis using both the Web of Science and Scopus databases with the application of bibliometric approaches longitudinally, as well as focusing on sub-topics like artificial intelligence in public services, digital transformation and trust, or digital government and public sector performance, etc. On the whole, it can be stated that the area of digital government becomes more and more developed and complex with high thematic development but poor collaboration of institutions and research networks. While being globalized, it

is far from being integrated with only some countries having central positions, while others remain peripheral.

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SECTION 5: ACCOUNTING

FROM ADOPTION TO PRACTICE: SUCCESS FACTORS AND CHALLENGES IN CAF IMPLEMENTATION ACROSS EUROPE

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Abstract: *The purpose of this paper is to present the evolution of the CAF model in Europe, to analyse best practices and challenges faced by public institutions, and to identify the quality performance indicators within the results criteria of the CAF 2020. The research methodology is based on literature review and content analysis of the best practices nominated by EIPA. The resources used included scientific articles in the field and official EUPAN and EIPA reports. The study's results show that the competence, agility, and quality of the staff represent key elements in achieving service quality from the perspective of the analyzed case studies. The main challenges identified are resistance to change and lack of training, limited institutional capacity for coordination and trouble in establishing communication channels. The quality performance indicators associated with the CAF result criteria includes measure related to: citizen satisfaction, such as waiting time, number of complains, access to information; people results, such as training participation, employee satisfaction; social responsibility, such as energy consumption and community engagement; key performance results, such as budget execution or use of ICT, etc. All of these indicators illustrate the multidimensional nature of performance assessment in public institutions. The qualitative nature of the analysis, the subjectivity involved in interpreting best practices, and the restricted number of case studies analysed represent the limitations of the present paper. Despite these limitations, the research provides public institutions with a structured overview of qualitative performance indicators and an overview of challenges they could face during the implementation of the CAF model.*

Key words: *self-assessment, quality, public services, indicators*

JEL: H83, O38, M12, M14

Introduction

Public sector organizations operate in a dynamic environment that requires a constant adaptation to changing conditions and existence of a quality service measurement system represents an asset to a public institution. Performance measurement is not just a management function but also a field of research, making significant contributions to the qualitative improvement of organizational processes. Performance measurement has become a cornerstone in public service delivery, with the aim of enhancing organizational effectiveness, accountability, and stakeholder satisfaction (Tanny & Zafarullah, 2023). The impact of performance measurement systems is far-reaching, affecting not only objective service delivery outcomes but also subjective perceptions of citizens and other stakeholders (Yang & Northcott, 2019). Understanding this impact is critical for governments seeking to improve service quality, trust, and satisfaction among diverse user groups (Lee & Kim, 2024). The benefits of performance measurement in public institutions are numerous, such as identifying and focusing on the core decisions of public sector organizations, driving the development of internal processes, increasing employee motivation for improvement, and defining the entity's improvement path. All these advantages contribute to a growing interest in enhancing the quality of public services. Starting from the question: "How can we best meet the needs of citizens?", public institutions are increasingly concerned with the continuous improvement and diversification of the services offered to their citizens. Effective management relies on effective measurement of performance and its outcomes. It is considered that the first condition for development and success is to develop a system for measuring and implementing performance (Fobé, Mulligan, & Gerson, 2021).

Performance indicators are essential tools for evaluating and improving the quality, efficiency, and effectiveness of public services across different sectors and regions (Zhang et al., 2024). The literature highlights a diversity of indicators dedicated to measure input- resource used, output- service delivered, outcome-impacts achieved, efficiency, and effectiveness measures, each serving unique roles in public administration and service delivery (Aljuwaied et al., 2024; Bartolacci et al., 2025). Their application represents a support for benchmarking processes, inform public policy-makers, and ensuring accountability in public institutions (Davidescu et al., 2025). The development of performance indicators in public services attract attention due to their potential in improving accountability, efficiency, and service quality (Bartolacci et al., 2025). But there are still challenges and limitations that hinder the effective creation, implementation, and evaluation of these indicators, considering the complexity of public sector environments and the diversity of stakeholder expectations (Aljuwaied et al., 2024). Difficulties related to integration in coherent framework of different types of indicators, limitation in data quality and availability, selecting relevant indicators that reflects accurately the outcome, and the increasing impact of digitalization on performance management systems are just some of the challenges that public administrators face (Bartolacci et al., 2025).

Kalfa and Yetim (2018) state that common problems in inefficient public administration include high taxes, inefficient use of resources, budget deficits, inflation, and high unemployment. These problems cannot be effectively addressed using traditional bureaucratic methods. Therefore, the adoption of Total Quality Management (TQM) was considered appropriate to obtain successful, quality-orientated outcomes and to establish a performance measurement system that would identify the organisational boundaries and clarify the resources available to it (Asensio, Evaristo, & Martins, 2021). Public sector organizations are process-orientated rather than results-orientated, which is why they encounter a number of difficulties in adapting performance measurement models (EIPA, 2020). The central challenge of public administration is considered to be the provision of high-quality programmes and services in a manner that optimises the use of available resources. This requires meeting both the demands of citizens for high-performing public services and the objectives of society and policymakers. Achieving these goals involves ensuring employee sustainability and motivation, guaranteeing and improving the quality of public services for users, and strengthening transparency within organizations. Consequently, specific models that facilitate strategic planning, operational effectiveness, efficient governance, rigorous evaluation, robust public trust, and continuous quality improvement have become essential elements in fulfilling the organisation's mission over the years (Asensio, Evaristo, & Martins, 2021).

Işoraitë (2008) and Moxham (2008) examine performance measurement in public sector organizations, finding that private sector models cause difficulties because for the public organizations processes quality are more important than outcomes. This specific characteristic led to the development in the 20th century of one of the fundamental models of quality management dedicated to public institution, the Common Assessment Framework (CAF). The fundamental principle of the CAF model is to initiate an evaluation process at various levels of public administration: central, regional, or local. The model analyses how the organization and public management are structured, with the aim of evaluating performance, identifying strengths and opportunities for improvement, followed by using the information obtained to generate positive changes, thereby ensuring continuous improvement. The CAF model provides a simple, user-friendly, accessible, free of charge, and suitable framework for the self-assessment of organizations across the entire public sector, regardless of their area of activity (EIPA, 2020). This framework is based on the premise that excellence in organizational performance, citizen satisfaction, staff satisfaction, and societal satisfaction is driven by leadership that directs strategy, human, material, and financial resource planning, partnerships, and processes toward achieving objectives. The holistic approach to performance analysis allows for a multidimensional perspective on the organization,

which consists of collaboration between managers and employees—who are within the system—and citizens—who are the beneficiaries of the service and are outside the system's configuration. Managers use this tool as a "compass" that guides them toward achieving excellence. In addition to enabling the organization to conduct an independent assessment by graphically analysing the cause-and-effect relationship between organizational factors and the results obtained, this model supports public organizations in improving their own performance and facilitates the dissemination of specific management ideas among member states (Pollitt & Bouckaert, 2017).

The purpose of this study is to present the path of the CAF model evolution and identify the performance indicators used in CAF model implementation. Based on review and analysis of existing literature and reports published by EIPA and EUPAN, it also aims to describe the main challenges and key success factors associated with practical use of the model.

The CAF model in EU

Common Assessment Framework - history, structure, excellence principles

Since the first formulation of the CAF model in 1998 until the inauguration in 2000, the model support changes and finally evolved into a self-assessment instrument, developed by contribution of the European Public Administration Network (EUPAN), the German University of Administrative Sciences in Speyer, and the European Institute of Public Administration (EIPA). The initiative originated from the collaboration of ministries responsible for public administration in EU member states, with the primary objective of improving the quality of services provided to citizens by aligning with a unified European vision (Kalfa & Yetim, 2018). The expansion and adaptation of the CAF model in public organizations across EU member states were based on the EU's 2000 Lisbon Strategy, which aimed for a competitive, knowledge-based economic model, broad political and economic reforms, an efficient public administration, and effective results-based management mechanisms.

The first version of the CAF model was presented at the first EU conference on quality in public organizations, held in Lisbon in 2000, where participants were invited to share their best practices for ensuring high-quality service delivery to citizens. Subsequently, the voluntary implementation of the CAF model was proposed, with the first official version launched in 2002 at the second EU conference on quality in public administration. A second version of the CAF model was introduced in 2006 at the fourth EU conference on sustainability through quality in the public sector. Based on feedback received from EIPA, a third version of the CAF model was developed and published in 2012. The latest version released, the fifth, was the CAF2020 model, which is currently being implemented. The periodic development of new versions of the CAF model is essential to maintain the tool's relevance in the dynamic context of public administration. Factors such as increased diversity, the emphasis on sustainability, accelerated digitalization, and the need for agility have necessitated the ongoing updating of the CAF model (EIPA, 2020). The CAF model is structured around nine criteria, which define the two components of the model: the enablers and the results. These 9 criteria identify the main aspects that must be taken into account in any organizational analysis. Criteria 1–5 refer to managerial practices, that is, what the organization does and how it approaches tasks related to leadership, personnel, strategy, planning, partnerships, resource management, and procedures. Criteria 6–9 focus on outcomes related to citizen/customer satisfaction, staff satisfaction, social responsibility, and key performance indicators. Each criterion is further divided into a list of sub-criteria. The 28 sub-criteria identify the main aspects to be considered when evaluating an organization. They are illustrated with examples that explain the content of the sub-criteria in detail and suggest possible approaches to explore how the administration meets the requirements expressed in the sub-criteria. The circularity of the model for integrating evaluation findings into determinants and outcome criteria in managerial practices contributes to a continuous cycle of innovation and learning that accompanies organizations on their path to excellence (EIPA, 2020).

Thijs (2013) identifies the top five reasons why organizations choose to use the CAF model. The public sector organizations opt to implement the CAF model to identify their strengths and areas for improvement, to enhance organizational performance, to involve staff in organizational management as a means of motivating them, due to staff's heightened sensitivity to quality, and when it appears as a directive from top management. The author notes that financial issues, rewards in the form of national awards or distinctions, competition, or participation in innovation programs at the local, regional, or national level are factors that do not generate interest in applying the model.

In addition to providing a qualitative assessment of an organization's strengths and weaknesses, the CAF model offers the possibility of obtaining a quantitative assessment of the organization's performance through a scoring system that measures the degree to which the objectives set out in strategic plans have been achieved. Balaboniene and Vecerskiene (2015) state that the Balanced Scorecard (BSC) is the tool that monitors strategy implementation at all levels of the organization by collecting the information necessary to describe the current situation and to anticipate changes if certain tasks have not been implemented. As noted in several CAF self-assessment reports, enablers and results are not two separate entities within the organization, as they are in a cause-and-effect relationship: enablers represent the causes, and results represent the effects, and the feedback from the latter to the former is also part of the process. These stages are characteristic of the PDCA (Plan, Do, Check, Act) cycle, which plays an essential role in applying the scoring criteria. According to the PDCA approach, regular reviews are conducted during the assessment process to develop a plan to address weaknesses and enhance strengths. The quality of this information and systematic analysis completes the CAF model cycle, integrating it into the continuous improvement process, which enables the organization to operate at a higher level of self-reflection. The two assessment methods provided by the CAF model are the "classic" score and the "adjusted" score, both based on the PDCA cycle. The "classic" CAF score provides an overall assessment of each subcriterion, indicating the PDCA phase in which the subcriterion is located. The second model, known as the "adjusted" CAF score, reflects a more detailed analysis of the subcriteria, as it is based on the evaluation of each subcriterion across all phases of the PDCA cycle simultaneously and independently (EIPA, 2020). The process facilitates a holistic review of the organization's priorities and provides a way to examine whether critical actions and support, including financial resource allocation and human resource planning, are aligned with the organization's mission, vision, objectives, and plans (Asensio et al, 2021).

Excellence in the public sector depends on the ability of leaders to deliver public services competently, effectively, and efficiently, using high-quality practices and staff committed to working collectively for the public good, to meet a specific set of societal needs and expectations. The CAF 2020 model provides support in achieving excellence by articulating the 8 principles of excellence. Thijs (2013) argues that these fundamental principles of excellence, initially defined by EFQM (The European Foundation for Quality Management) and adapted for use in the public sector, are essential for integrating TQM principles into the public sector's philosophy, facilitating the transformation process from a bureaucratic public organization to one oriented toward total quality. The 8 principles reflect organizations' commitment to results, citizens and customers, leadership, process management, staff development and engagement, learning and continuous improvement, innovation, partnership development, corporate responsibility and sustainability, agility, diversity, and digitalization. Results orientation emphasizes the importance of focusing on objectives and achieving them, while citizen and customer engagement highlights the need to understand and respond to their needs and expectations. Leadership and consistency in achieving the goal underscore the need for a clear vision and strong values, which serve as a guide for employees in achieving organizational objectives, while management through procedures and actions indicates the importance of making decisions based on relevant data and information to ensure the efficiency and effectiveness of operations. Furthermore, the principles emphasize the importance of continuous staff development

and the promotion of an organizational culture that encourages continuous learning and innovation. These aspects contribute to increased employee engagement and motivation, and, consequently, to improved organizational performance. Developing mutually beneficial partnerships is essential for achieving organizational goals and embracing corporate and social responsibility is crucial for supporting sustainability and meeting sustainable development goals. Agility enables organizations to adapt quickly to change and innovate continuously, while diversity and innovation help reflect and meet the diverse needs of the communities they serve. Digitalization is a key aspect in the modern era, facilitating the efficiency and accessibility of public services, but it requires a responsible approach to data protection and ensuring equal access. Taken together, these principles represent the foundation for continuous improvement and innovation in public sector organizations.

Performance quality indicators in public services and CAF criteria

In spite of comprehensive structure of the CAF model, that integrates enablers with results using a cause-effect logic, assuring a continuous improvement cycle, there is still a gap in the literature about integration of the model through performance indicators. Academic literature presents the diversity of performance indicators used in public services, including input, output, outcome, efficiency, and effectiveness measures which target the resource used, services delivered, impacts achieved, input-output ratios, and achievement of objectives (Zhang et al., 2024). Yet, these indicators are applied in a fragmented manner, for example input and output indicators are more used in areas like urban infrastructure and administrative performance measurements (Zhang et al., 2024). Also, there is an imbalance between efficiency and effectiveness indicators, because the first indicators are unduly emphasized at the expense of service quality. Several studies argue that, in public administration, the efficient use of time, financial resources, and personnel is prioritized over citizen satisfaction and service quality (Bartolacci et al., 2025; Shi et al., 2023).

The lack of integrated reports that systematically combine input, output and outcome indicators for a holistic evaluation of public sector institutions across sectors and governance levels is another limitation of current performance reporting (Shi et al., 2023). The research that analyses the intersection between user satisfaction, quality of service outcome, and traditional resource-based indicators is limited (Solaz-Moreno et al., 2025), despite the evidence that service quality and performance measurement influences citizen satisfaction and trust in public organisations (Psomas et al., 2024). The increasing role of digitalisation complicates the relevance of performance indicators because there is still insufficient understanding of how digital transformation affects the relevance, selection, and effectiveness of traditional indicators (Erben et al., 2026). There are also data-related challenges, including issues of data quality, methodology, and technical skill gaps, which obstruct accurate performance measurement and effective decision-making processes (Bartolacci et al., 2025). It is a tendency for public organisations to prioritise easily measurable indicators over more complex but meaningful measures, like processing time or number of services delivered instead of citizen satisfaction or long-term societal impact. The literature concludes that public services organizations face multiple operational and contextual challenges. These include limited digital infrastructure, difficulties in inter-agency coordination, resistance to change, and the challenge of aligning indicators with stakeholders' expectations and perceptions of service quality (de Menezes et al., 2022; Salemans & Budding, 2022). The CAF model, as presented in the present study, provides a structured framework for assessing organisational performance. However, in the presented context, research is still needed in order to link performance quality indicators to the CAF model result criteria. This would ensure the integration of the input, output, outcome, efficiency, effectiveness, and user centred measures within an excellence quality management model.

To identify what are the used performance quality indicators reported by public institution that implement the CAF model, the study analyses the EUPAN report (2025), which describes the nominated 18 golden cases by EIPA at the Warsaw's Conference. Through a content analysis methodology, the paper determine what measurements for quality improvement were used by

European public institutions to report their achievement regarding the citizens, people, social responsibility and key performance results, after implementation of the CAF model (see Table 1).

Table 1. Quality indicators attributed to CAF criteria

CAF element	Indicator	Type of indicator	Aspect addressed
Citizen Result	Waiting time	Efficiency	Service accessibility
	Number of complaints	Quality	User dissatisfaction
	Access to information	Transparency	Openness
	Participation in survey	Engagement	Citizen involvement
	Transparency of decision	Governance	Accountability
People results	Training days per employee	Capacity	Skill development
	Participation in training	Engagement	Employee involvement
	Employee review	Stability	HR sustainability
	Absenteeism	Efficiency	Workforce discipline
	Employee satisfaction	Satisfaction	Internal climate
Social Responsibility	Energy consumption	Sustainability	Environmental impact
	Recycling rate	Sustainability	Resource efficiency
	Environmental projects	Responsibility	Green initiatives
	Community partnerships	Engagement	Social integration
	Volunteer activities	Social value	Civic contribution
Key Performance Results	Graduation rates	Effectiveness	Output quality
	Drop-out rates	Effectiveness	System efficiency
	Exam results	Quality	Performance outcome
	Employment rates	Impact	Labour market relevance
	Cost per student	Efficiency	Resource use
	Budget execution	Financial	Fiscal discipline
	Audit results	Compliance	Governance quality
	Use of ICT	Digitalisation	Technological capacity

Source: Authors' adaptation based on EUPAN (2025).

Success factors and challenges in the CAF model implementation

From the inauguration year of the CAF model in European Union until present, the practitioners and specialized institution like EIPA and EUPAN, discussed and presented many cases of public institutions that can serve as an example of implementation of the CAF model. As one of the model objectives is the benchmarking, which refers to learn from each other, public institutions are encouraged to embrace examples presented in other countries and use as inspiration for improving quality of the public services they provide. The following cases are presented in order to underline the success factors and challenges that institution faced during the implementation.

PARCO, the office coordinating public administration reform in Bosnia and Herzegovina, has implemented the CAF model to improve efficiency and transparency in public administration. The decision to pilot the CAF model was influenced by the strategic objective of developing a modern and efficient public administration compatible with EU standards. An inter-institutional working group on quality management was formed, which, following certification obtained in accordance with the requirements of European bodies, contributed to the introduction of quality management tools in public administration. After identifying key issues through self-assessment, an action plan was designed, establishing the priority actions necessary to be undertaken for improvement. Specifically, emphasis was placed on internal and external communication with third parties, thereby establishing two-way communication through the implementation of user and employee satisfaction surveys.

Digitalization was another area improved through the redesign of the website and the development of digital strategies. By applying the CAF model and the PDCA cycle, PARCO was able to identify and address existing issues in a systematic manner. The experience gained was shared with other public administration organizations, contributing to the overall improvement of administrative processes and communication throughout the country. Currently, over 20 organizations at various administrative levels in Bosnia and Herzegovina use the CAF model, and these processes are included in strategic documents for the modernization of public administration (Avdagić, Begić & Delić, 2023).

In line with the government's strategy for public administration, the Ministry of Education, Science, and Sport (MESS) in Slovenia launched its first self-assessment using the CAF model in 2017. This set them on a fast track to improvement, which generated a snowball effect through the implementation of new approaches resulting from the application of the process in the first phase. During the first self-assessment, a lack of information regarding employee satisfaction, organizational climate and culture, values, and knowledge of the MESS mission and strategy was identified. By using a hybrid approach in selecting project team members, adequate coverage of social responsibility areas and a variety of experiences brought to the self-assessment process were ensured. Setting up a dedicated website for the CAF model implementation project on the SharePoint 2016 platform facilitated communication and collaboration among team members, contributing to the efficient management of documentation and relevant information. Training workshops proved to be an effective way to overcome the team members' initial lack of experience and knowledge, improving their skills and understanding of the CAF model. The exchange of best practices with other ministries and the conduct of a satisfaction survey at the end of the project contributed to enriching the self-assessment process and identifying innovative solutions for improving organizational performance. The inclusion of strategic topics in the self-assessment process led to a more in-depth analysis and the identification of clear priorities for improving MESS performance. Overall, MESS's experience demonstrates that applying the CAF model can be beneficial and replicable in other similar organizations, facilitating better resource management and continuous improvement of operations. Additionally, an opportunity was identified to develop a standardized methodology in collaboration with other relevant public institutions to enable comparisons with them. The process involved appointing representatives from various organizations and organizing training sessions on quality management and the CAF model to prepare project members, ensuring they were ready for each phase of the self-assessment process (Hauptman, 2023).

In Italy, could be observe how a public organization with a specialized field of activity, focused on mobility management and the development of the automotive sector in the country, chose to use the CAF model with the aim of improving the efficiency and effectiveness of its group management system. This was done to promote learning and the exchange of experience among the various ACI offices, in order to foster collaboration. Since 2012, by applying the CAF model with a focus on optimizing the cost-benefit ratio in small and medium-sized organizations, ACI has succeeded in developing direct relationships with citizens, improving internal and external communication channels. The implementation of the CAF model within the ACI Federation has brought about a series of remarkable achievements. These include the strengthening of positive relationships with local organizations and stakeholders, which has contributed to more effective communication and improved collaboration. Furthermore, the effective dissemination of a service culture and public value has strengthened ACI's reputation in the community and increased its positive impact. Moreover, the implementation of the CAF model has fostered an environment conducive to evaluation and learning from comparisons, thereby encouraging continuous improvement and the exchange of knowledge among the organization's members. These results highlight the success of the CAF model's implementation and its significant contribution to the development and consolidation of ACI (Pennacchio & Italo, 2023).

Romanian path to the CAF model

As Romania is a member state of the European Union, it has the opportunity to benefit from support from European organizations established with the aim of improving the quality of public services. Through these organizations, it has access to the set of best practices adopted at the European level by several countries that it can use as examples.

The process of improving service quality in public administration began in 2004 with the introduction of quality standards for monitoring and evaluating public services and the performance of civil servants. These standards established a fixed number of civil servants based on the quality requirements for each public service. In addition, a strategic planning system was developed for each public authority, tailored to the public services provided, including incentive schemes, to improve the quality of public services and stimulate innovation in the development and implementation of the Citizens' Charter. Through Government Decision No. 909/2014, the Strategy for Strengthening Public Administration 2014–2020 was approved, and the National Committee for Coordinating the Implementation of this Strategy was established. The main objective was for Romania to manage a public administration responsive to the needs of society by 2020. An important step in this direction was the Action Plan for the Phased Implementation of Quality Management within Public Authorities and Institutions 2016–2020, which generated funding requests through the Operational Program for Administrative Capacity (POCA) for the introduction of ISO standards, the CAF model, and Balance Scorecard instrument in public institutions. As a result, the number of public institutions implementing these tools has increased.

Conclusions

The analysis of the CAF model implementation in European public institutions highlights that the transition from formal adaptation to effective use of the model requires more than compliance with methodological requirements. Successful implementation depends on the coherence between organizational practices and improvement actions, which is reflected in the cause effect logic embedded in the CAF model and the PDCA cycle. For example, the quality of human resources, expressed through adaptability, competencies, and engagement, emerges as a key determinant of service quality. The study notice that the benefits of the CAF model become evident when the institution has strategic support, effective communication and collaboration mechanism, and sustained investment in staff development. The exchange of experience among institution and the benchmarking practices are meant to develop a culture of learning and continuous improvement.

The challenges identified in the literature and in the case studies about the CAF model implementation are shaped by the contextual factors, as employee's resistance to change, varying levels of digitalisation, and institutional capacity for coordination. There are also difficulties with integrating quality performance indicators, limitations in data availability and quality, and the tendency to use easily measurable indicators over those which reflect long term outcomes and citizen satisfaction.

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CONCEPTUAL INNOVATION IN THE PURPOSE OF INTERNAL AUDITING UNDER THE GLOBAL INTERNAL AUDIT STANDARDS (2025) AND ITS IMPLICATIONS FOR ORGANIZATIONAL GOVERNANCE

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Abstract: *Contemporary transformations within the international internal auditing framework increasingly emphasize governance efficiency, institutional responsibility, and sustainable managerial development. The adoption of the Global Internal Audit Standards reflects the increasing strategic integration of internal auditing within modern governance systems and highlights the growing importance of this function in supporting managerial coordination, institutional accountability, and organizational sustainability. This development generates the necessity to examine how the contemporary professional framework redefines the positioning, responsibilities, and strategic contribution of internal auditing within modern organizations. In this regard, particular attention is directed toward understanding how the revised formulation of the purpose of internal auditing influences governance strengthening and the broader perception of the internal audit function. The aim of the research is to analyze the conceptual innovation in the purpose of internal auditing introduced by the Global Internal Audit Standards (2025) and to assess its implications for organizational governance. The research is based on documentary analysis of the international regulatory framework in the field of internal auditing, using methods of conceptual analysis, comparison, and interpretation of the evolution of professional standards.*

The findings suggest that the contemporary professional framework considerably expands the understanding of internal auditing beyond traditional compliance-related activities, positioning this function as an important component of governance effectiveness, adaptive risk responsiveness, and long-term institutional development. In the context of the ongoing evolution of the internal auditing profession in the Republic of Moldova, this professional reorientation may support a clearer understanding of the contribution of internal auditing to accountability, managerial transparency, and the improvement of governance practices within the public sector.

Keywords: *internal auditing; organizational governance; Global Internal Audit Standards 2025; purpose of internal auditing; conceptual innovation; public sector governance*

JEL: M42, G34, H83

Introduction

The accelerated transformation of organizational environments, accompanied by increasing institutional complexity and the expansion of governance-related risks, has generated a gradual reorientation in the understanding of internal auditing within modern governance systems. Against this background, the contemporary professional framework developed by The Institute of Internal Auditors reflects the growing tendency to associate internal auditing not only with compliance verification and internal control assessment, but also with governance effectiveness, institutional accountability, and long-term managerial support. Previous academic discussions concerning the evolution of internal auditing similarly emphasized the gradual transformation of internal audit from a predominantly control-oriented activity toward a broader governance-support and organizational advisory function (Sarens, 2009). The contemporary professional framework increasingly associates internal auditing with organizational adaptability, governance consolidation, risk responsiveness, and sustainable institutional development. Consequently, internal auditing is progressively perceived not only as a mechanism for evaluating compliance and internal control systems, but also as an important

contributor to organizational accountability, managerial transparency, and long-term institutional stability.

The relevance of the research topic derives from the necessity to understand the conceptual implications generated by the new professional standards and the manner in which these transformations may influence the relationship between internal auditing, governance structures, executive management, and organizational decision-making processes. The new standards appear to reposition internal auditing within the broader architecture of governance by emphasizing its contribution to organizational value, strategic support, and institutional resilience.

Within the public sector of the Republic of Moldova, the national regulatory framework concerning internal auditing already incorporates several dimensions related to governance, risk management, and organizational accountability. Nevertheless, the Global Internal Audit Standards (hereinafter GIAS) conceptually strengthen these dimensions by explicitly emphasizing the contribution of internal auditing to organizational sustainability and value-oriented governance. This development may influence the future modernization of the national professional and methodological framework associated with internal auditing.

An additional dimension of the new professional approach concerns the growing interaction between internal auditing, ethical climate, and organizational culture. From this perspective, internal auditing may contribute to identifying institutional vulnerabilities related to ethical behavior, accountability deficiencies, and governance effectiveness, particularly in environments characterized by uncertainty and increased reputational exposure.

Recent scientific literature increasingly associates internal auditing with strategic governance, organizational performance, risk management, and institutional credibility. At the same time, the conceptual implications generated by the new GIAS remain insufficiently explored within the academic literature, especially regarding their influence on governance mechanisms and organizational sustainability.

Hazaea et al. (2023) demonstrate that contemporary internal auditing literature increasingly concentrates on governance effectiveness, risk management integration, organizational accountability, and strategic organizational support, while simultaneously emphasizing the fragmentation of existing conceptual approaches concerning the future role of internal auditing. Recent academic research reflects the gradual repositioning of internal auditing from a predominantly compliance-oriented activity toward a governance-support function associated with strategic oversight, institutional accountability, and sustainable organizational development. Contemporary studies increasingly emphasize the contribution of internal auditing to managerial transparency, governance effectiveness, and adaptive risk responsiveness, particularly in environments characterized by uncertainty and institutional complexity (Wang & Liang, 2025; Mita et al., 2025). At the same time, researchers highlight the growing interaction between internal auditing, organizational culture, ethical behaviour, and institutional credibility (Hayrettin & Caglan, 2023). Nevertheless, despite the growing academic interest in governance-oriented auditing, the broader implications generated by the broader implications associated with the Global Internal Audit Standards continue to receive limited academic attention, particularly regarding their potential influence on governance effectiveness, institutional adaptability, and sustainable managerial development (Hazaea et al., 2023).

The originality of the present study derives from approaching internal auditing not exclusively through the perspective of control and evaluative activities, but through its emerging role as an integrated component of governance, managerial coordination, institutional continuity, and long-term organizational support.

The research seeks to investigate the conceptual evolution associated with the contemporary international auditing framework and to evaluate its influence on governance arrangements, organizational effectiveness, and managerial risk coordination. The study integrates conceptual

interpretation, comparative assessment, documentary examination, and bibliometric investigation with the purpose of identifying the emerging directions shaping the contemporary development of internal auditing.

Research methodology

The research methodology relies on a mixed research design that combines interpretative examination, comparative evaluation, documentary investigation, and bibliometric exploration of publications related to internal auditing and governance-related studies. The bibliometric component of the research was developed using the Web of Science database with the purpose of examining the evolution of scientific interest, thematic diversification, and the interrelation between concepts associated with governance, accountability, managerial oversight, risk responsiveness, and audit effectiveness.

The bibliometric approach was additionally supported by previous systematic literature evaluations concerning internal auditing and governance-related studies (Hazaea et al., 2023), which provided conceptual orientation regarding the dominant research themes and the existing academic gaps within the field.

The initial search generated 1,676 scientific publications. Several stages of filtering and relevance selection were subsequently applied, including the limitation of the publication period to 2020–2026, the selection of articles and review papers, and the restriction of the analysis to research areas associated with Business, Finance, Economics, and Management. Following the application of the inclusion and exclusion criteria, the final bibliometric database consisted of 470 scientific publications.

The bibliometric data were processed using the bibliometrix analytical tool, which enabled the examination of publication dynamics, thematic evolution, conceptual networks, and the positioning of the principal research directions associated with internal auditing and organizational governance. In parallel, the study included the examination of the Global Internal Audit Standards, the International Professional Practices Framework, and the relevant scientific literature in order to identify the conceptual evolution of internal auditing from a predominantly compliance-oriented activity toward a strategic governance-support mechanism focused on organizational resilience, sustainable performance, and institutional value.

Basic content

The examination of the contemporary international professional framework highlights the existence of a substantial conceptual transformation regarding the understanding of the purpose of internal auditing within organizational governance systems. Earlier governance-oriented research already suggested that internal audit effectiveness depends not only on control procedures, but also on organizational positioning, managerial support, and governance integration (Arena & Azzone, 2009). Compared with the traditional approach, predominantly centered on compliance verification and control procedures, the new standards emphasize the strategic contribution of internal auditing to organizational adaptability, institutional accountability, and sustainable value-oriented governance. This transformation reflects the gradual transition from a control-dominated paradigm toward a governance-oriented perspective in which internal auditing becomes increasingly integrated into organizational decision-making, risk evaluation, institutional resilience, and strategic oversight processes. Consequently, internal auditing acquires a broader organizational significance associated with supporting managerial effectiveness, improving governance structures, and strengthening institutional sustainability.

The comparative analysis of the international professional framework and the national regulatory environment of the Republic of Moldova demonstrates the existence of several compatible conceptual dimensions related to governance, risk management, accountability, and organizational independence. However, the new professional standards provide a more coherent conceptual systematization by explicitly positioning organizational value and sustainability among the central

dimensions associated with internal auditing. The conceptual transformation identified in the research demonstrates that internal auditing is increasingly perceived as a multidimensional governance-support mechanism capable of contributing to strategic organizational stability, responsible decision-making, and institutional resilience. This transformation additionally reflects the increasing organizational expectations regarding the contribution of internal auditing to responsible governance practices, institutional reliability, ethical conduct, and managerial legitimacy.

Figure 1 presents the progressive evolution of internal auditing from a predominantly compliance-focused activity toward an integrated governance-support function characterized by strategic coordination, dynamic risk responsiveness, and sustained organizational continuity.

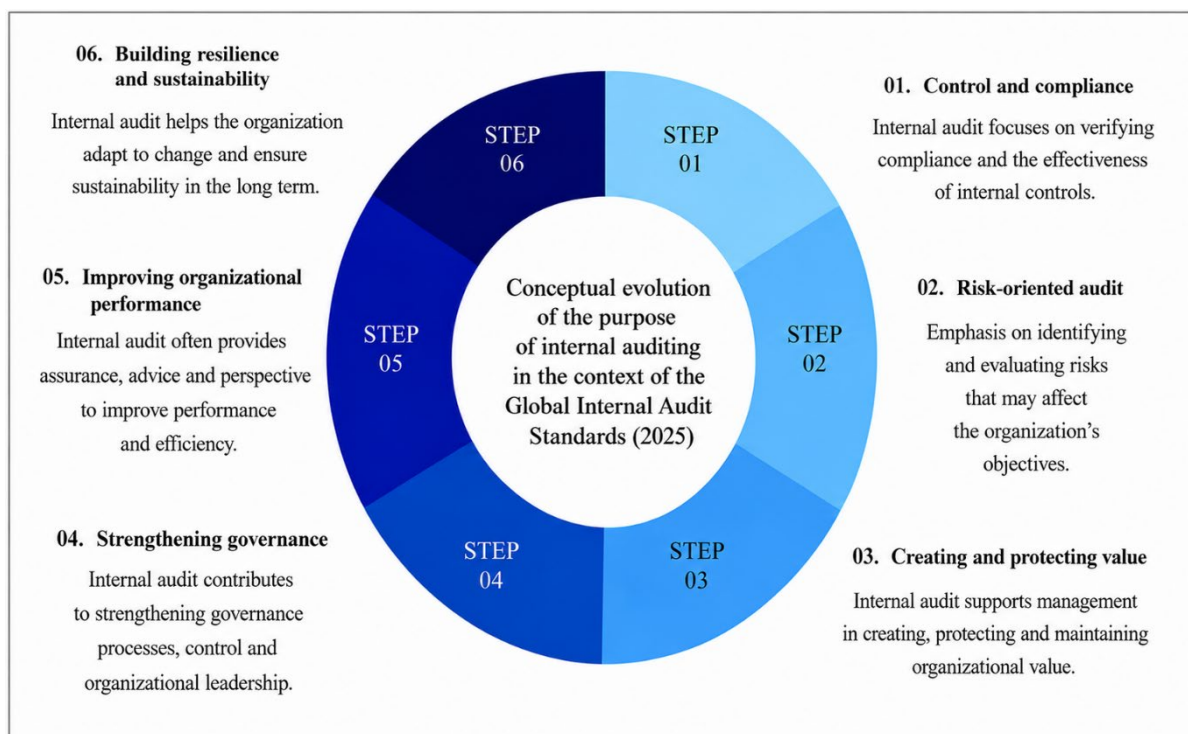


Figure 1. Conceptual transformation of the purpose of internal auditing under the GIAS (IIA, 2024)

Source: Prepared by the author based on the (The Institute of Internal Auditors, 2024)

The first stage reflects the traditional orientation toward control and compliance, where internal auditing primarily focuses on verifying conformity and evaluating the effectiveness of internal controls. The second stage emphasizes the transition toward risk-oriented auditing, characterized by the identification, assessment, and monitoring of risks capable of affecting organizational objectives. This evolution reflects the broader organizational integration of enterprise risk management practices within governance systems and managerial decision-making processes (Beasley et al., 2005). The third stage introduces the concept of organizational value creation and protection, which represents one of the most significant conceptual innovations of the GIAS (IIA, 2024). In this context, internal auditing is no longer limited to detecting deficiencies, but actively contributes to supporting management in maintaining sustainable organizational value. Contemporary empirical research additionally confirms that enhanced internal audit quality contributes significantly to organizational value creation through the optimization of risk management processes and governance effectiveness (Wang & Liang, 2025). The fourth stage reflects the strengthening of organizational governance through the increasing involvement of internal auditing in governance-related coordination, institutional responsibility, managerial oversight, and organizational decision processes. At the same

time, the fifth stage reflects the increasing contribution of internal auditing to operational improvement through analytical evaluations, advisory support, and forward-looking recommendations aimed at strengthening institutional adaptability and managerial performance.

The final stage emphasizes the role of internal auditing in supporting organizational resilience and sustainability. Through the integration of governance, risk management, internal control, and strategic foresight, internal auditing contributes to the organization's capacity to anticipate change, respond to uncertainty, and maintain long-term institutional sustainability. Recent research additionally demonstrates that effective internal control systems, adaptive risk assessment, and governance coordination significantly improve organizational resilience during periods of institutional uncertainty and crisis conditions (Tanbour et al., 2025). A significant consequence of this conceptual transformation concerns the increasing integration of internal auditing within governance architecture, particularly in relation to board supervision, institutional independence, managerial accountability, and oversight responsibilities associated with the internal audit function. At the same time, the new standards create the conceptual foundations for extending the role of internal auditing toward the evaluation of ethical governance environments and organizational behavioural dimensions capable of influencing governance effectiveness, institutional integrity, and organizational reputation. The bibliometric analysis additionally confirms the growing academic interest in the relationship between internal auditing, governance, risk management, quality, and organizational impact. The conceptual network and thematic positioning analyses demonstrate that internal auditing increasingly occupies a central position within contemporary governance research, particularly in relation to organizational performance, accountability, and strategic management processes.

Recent studies emphasize the transformation of internal auditing from a traditional compliance-oriented activity toward a strategic governance mechanism focused on risk management, organizational resilience, and value creation (Wang & Liang, 2025; Mita et al., 2025). At the same time, contemporary research highlights the increasing involvement of internal auditing in governance processes, organizational culture, and ethical sustainability (Hayrettin & Caglan, 2023). These developments are conceptually reinforced by the Global Internal Audit Standards (IIA, 2024), which redefine the purpose of internal auditing through assurance, advice, insight, and foresight oriented toward creating, protecting, and sustaining organizational value.

In order to substantiate the conceptual framework of the research and identify the main directions of development in the scientific literature concerning internal auditing, a bibliometric analysis of publications indexed in the Web of Science database was conducted. The use of bibliometric analysis enables the identification of research trends, the evolution of scientific production, and the conceptual relationships between themes associated with internal auditing, organizational governance, risk management, and audit quality.

Figure 2 highlights the general characteristics of the analyzed bibliometric database. The research included 470 scientific documents published during the period 2020-2026, originating from 184 scientific sources and authored by 1168 researchers. The high number of references identified (21,507) reflects the complexity and interdisciplinary nature of research concerning internal auditing and organizational governance. At the same time, the international co-authorship rate of 31.7% indicates the existence of significant global academic interest regarding the transformation of the role of internal auditing in the context of contemporary organizational and institutional challenges.



Figure 2. Evolution of Scientific Production on Internal Auditing (2020–2026)

Source: Prepared by the author based on Web of Science data processed using bibliometrix

The analysis also reveals an average of 2.97 co-authors per document and an average of 8.268 citations per article, suggesting both the collaborative character of research and the scientific relevance of the analyzed field. Furthermore, the large number of authors' keywords identified confirms the thematic diversification of contemporary research on internal auditing, particularly in relation to governance, risk management, organizational performance, and value creation.

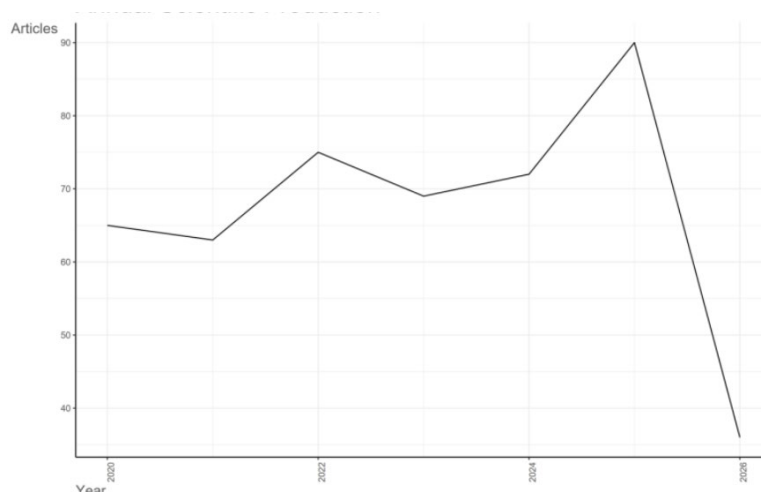


Figure 3. Evolution of scientific production on internal auditing (2020-2026)

Source: Prepared by the author based on Web of Science data processed using bibliometrix.

The growing trend of scientific production presented in Figure 3 reflects the increasing academic interest in internal auditing, particularly in relation to organizational governance, risk management, and organizational performance. The evolution of publications during the analyzed period demonstrates the expansion of contemporary research directions associated with the strategic role of internal auditing within modern organizations. The lower value recorded for 2026 can be explained by the fact that the year was incomplete at the moment of bibliometric data extraction.

The conceptual structure illustrated in Figure 4 reflects the increasing strategic relevance of internal auditing within governance-related scientific research. The network of interconnections suggests the growing integration of internal auditing into discussions concerning governance effectiveness, accountability, managerial performance, and institutional adaptability.

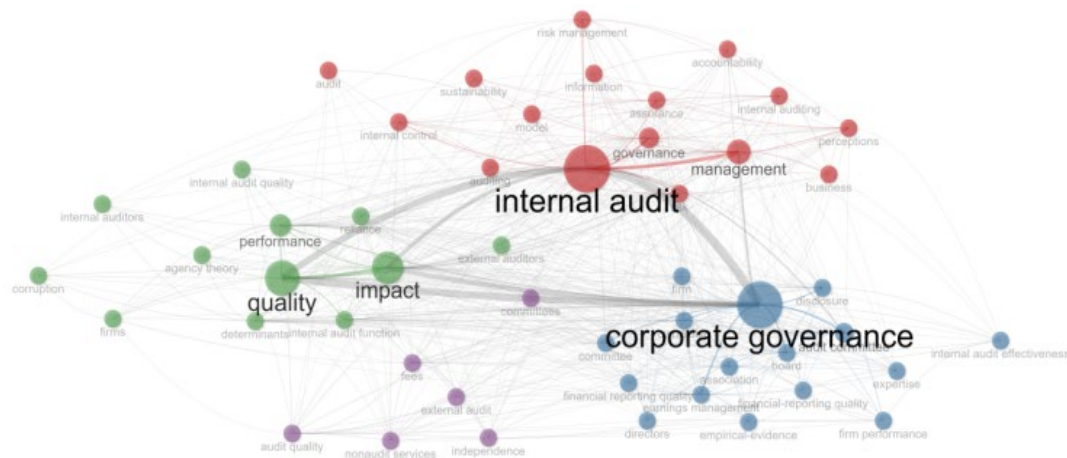


Figure 4. Conceptual network of research on internal auditing and organizational governance
 Source: Prepared by the author based on Web of Science data processed using bibliometrix.

The intensity of these relationships reflects the growing orientation of contemporary research toward the strategic role of internal auditing in strengthening governance mechanisms, improving organizational performance, and supporting managerial decision-making processes. The figure also demonstrates the interdisciplinary character of internal auditing research and the increasing integration of governance, accountability, quality, and organizational sustainability dimensions within the academic literature.

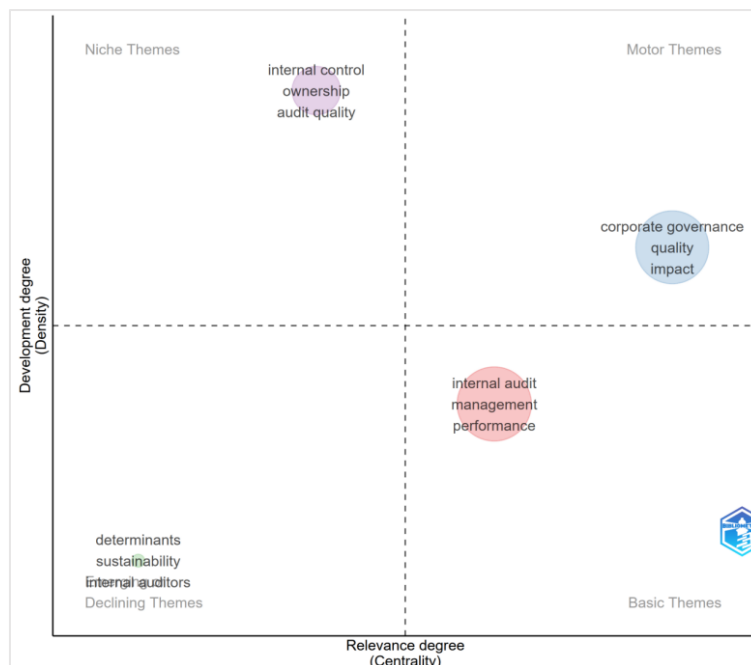


Figure 5. Thematic positioning of concepts associated with internal auditing
 Source: Prepared by the author based on Web of Science data processed using bibliometrix.

The thematic configuration presented in Figure 5 indicates the increasing concentration of contemporary internal auditing research around governance-related dimensions and managerial effectiveness. The prominence of themes connected with governance, organizational quality, managerial impact, and performance assessment demonstrates the continuous broadening of internal auditing beyond its conventional control-focused orientation. Simultaneously, concepts associated

with internal audit, managerial coordination, and organizational effectiveness emerge as significant integrative themes supporting the growing strategic relevance of internal auditing within modern governance systems. The figure additionally illustrates the diversification of contemporary research interests through the inclusion of themes related to audit quality, sustainability, ownership structures, and internal control mechanisms. The thematic positioning of these dimensions reflects the ongoing transformation of internal auditing into a multidimensional governance-support function integrated with organizational accountability, institutional performance, and sustainable value development.

The correlation between the bibliometric analysis and the examination of the GIAS (IIA, 2024) suggests the existence of a strong relationship between the evolution of the contemporary professional environment and the current scientific interest in governance-related auditing research. The bibliometric findings reveal a growing concentration of academic attention on themes associated with managerial oversight, adaptive risk responsiveness, institutional effectiveness, accountability, and long-term development, dimensions that are increasingly reflected within the contemporary international auditing framework.

Simultaneously, the thematic and conceptual evaluations indicate that internal auditing is progressively moving beyond its traditional control-centered orientation and becoming more closely connected with governance coordination, managerial support, institutional adaptability, and strategic organizational continuity. From this perspective, the GIAS can be understood not merely as a formal professional framework, but as a reflection of the ongoing transformation affecting both academic and professional perspectives regarding the evolving significance of internal auditing within contemporary governance systems. The research findings consequently demonstrate the existence of a substantial redefinition of the purpose of internal auditing. This evolution reflects the transition from a primarily control-centered activity toward an integrated governance-support function associated with organizational value enhancement, strategic advisory involvement, ethical responsibility, and long-term institutional adaptability.

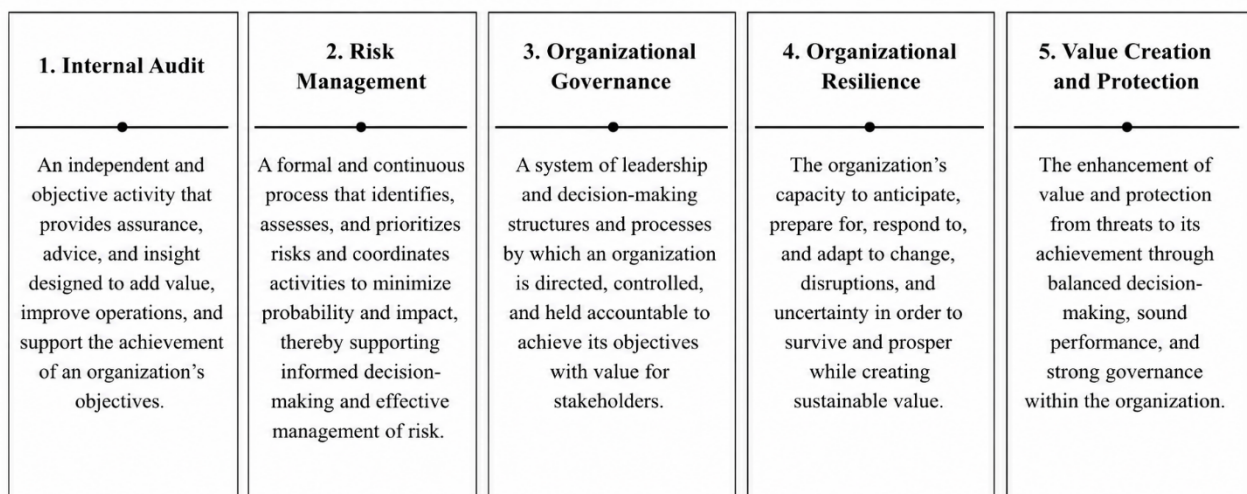


Figure 6. Functional interdependence between internal auditing, risk management, organizational governance, organizational resilience, and value creation

Source: Prepared by the author based on the GIAS (IIA, 2024)

In order to further illustrate the multidimensional transformation of the role of internal auditing within contemporary organizational governance, Figure 6 presents the functional interdependence between internal auditing, risk management, organizational governance, organizational resilience, and value creation. The increasing integration between internal auditing and enterprise risk management reflects the growing importance of coordinated governance mechanisms capable of supporting organizational

adaptability, strategic oversight, and institutional continuity (Beasley et al., 2005). The figure synthesizes the main conceptual dimensions highlighted both by the Global Internal Audit Standards (IIA, 2024) and by the contemporary scientific literature concerning the strategic evolution of internal auditing.

The research findings highlight that the GIAS (IIA, 2024) introduce a substantial reconceptualization of the purpose of internal auditing. The analysis demonstrates that internal auditing is no longer limited to traditional compliance verification and control activities, but is increasingly positioned as a multidimensional governance mechanism oriented toward organizational value creation, strategic support, and institutional resilience.

The results also emphasize the strengthening of the relationship between internal auditing and governance structures, particularly through the increased importance assigned to organizational independence, board oversight, accountability, and risk management processes. Simultaneously, the new standards expand the functional scope of internal auditing through assurance, advice, insight, and foresight intended to improve organizational performance and support managerial decision-making.

Another important aspect highlighted by the research concerns the growing relevance of ethical climate and organizational culture within the governance process. In this context, internal auditing acquires an extended role in identifying ethical and cultural vulnerabilities capable of influencing organizational integrity, credibility, and long-term sustainability.

Overall, the findings confirm the existence of a significant conceptual transformation in the understanding of the purpose of internal auditing, characterized by the transition from a predominantly control-oriented activity toward a strategic governance mechanism integrated into value creation, organizational resilience, and sustainable institutional development.

Conclusions

The research demonstrates that the contemporary evolution of the international professional framework has generated a substantial transformation in the understanding of the purpose and strategic significance of internal auditing within organizational governance systems. The Global Internal Audit Standards contribute to expanding the institutional role of internal auditing beyond traditional compliance verification toward a multidimensional governance-support mechanism associated with organizational resilience, strategic oversight, accountability, and sustainable value-oriented development.

The conceptual and bibliometric analyses confirm the growing integration of internal auditing into governance processes, risk responsiveness, organizational performance, and institutional sustainability. The increasing academic attention dedicated to governance, accountability, resilience, quality, and strategic management reflects the consolidation of internal auditing as an essential component of modern organizational governance.

The findings also indicate that the contemporary understanding of internal auditing extends toward the evaluation of organizational culture, ethical climate, and institutional credibility. Consequently, internal auditing acquires a broader analytical and strategic dimension capable of contributing to long-term organizational adaptability and institutional sustainability.

In the context of the Republic of Moldova, the research highlights the existence of several regulatory and conceptual compatibilities between the national framework and the principles promoted by the Global Internal Audit Standards. Nevertheless, the new standards provide a more coherent strategic orientation focused on organizational value, sustainability, and governance effectiveness, which may support the future modernization of the national internal audit framework.

The author's contribution consists in developing an integrated conceptual interpretation regarding the transformation of the evolving role of internal auditing in relation to the contemporary international

auditing framework and modern governance practices. The originality of the study is reflected through:

- interpreting internal auditing as an expanding managerial and governance-related activity associated with institutional continuity, accountability, and adaptive organizational coordination;
- combining bibliometric exploration with comparative and interpretative examination of the contemporary professional auditing environment;
- emphasizing the growing interaction between recent scientific research and the ongoing professional evolution of international internal auditing standards;
- developing conceptual representations regarding the functional interdependence between internal auditing, governance, risk management, organizational resilience, and sustainable organizational development;
- extending the interpretation of internal auditing toward dimensions related to organizational culture, ethical climate, accountability, and institutional credibility.

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DIGITAL TOOLS FOR ANALYSIS OF FINANCIAL STATEMENTS OF JOINT-STOCK COMPANIES

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Abstract: *The article examines the role and significance of digital tools in the analysis of financial statements of joint-stock companies within the context of the global digital transformation of the economy. In modern conditions, characterized by rapid technological development and increasing volumes of financial data, the application of digital technologies becomes a crucial factor in improving the efficiency and quality of financial analysis.*

The aim of the study is to identify the key digital instruments used in financial analysis and to assess their impact on the effectiveness of managerial decision-making and the overall performance of enterprises. The research methodology is based on general scientific methods, including analysis, synthesis, comparison, and generalization, as well as a systematic approach to evaluating the transformation of financial analysis under digitalization.

The study explores the main directions of financial statement analysis, including liquidity, solvency, financial stability, and profitability, and highlights the role of digital tools in enhancing these analytical processes. Particular attention is paid to the use of spreadsheet software, business intelligence systems, and programming tools for processing large volumes of financial data and generating analytical insights.

The findings demonstrate that the integration of digital technologies significantly improves the accuracy, speed, and depth of financial analysis, reduces the risk of human error, and enables real-time data processing. Moreover, digital tools contribute to increasing the transparency and accessibility of financial information, which is especially important for joint-stock companies due to their obligation to ensure accountability to shareholders and investors.

Key words: *financial analysis, digital transformation, digital tools, financial statements, business intelligence systems, big data analytics, predictive analytics, financial forecasting, managerial decision-making, joint-stock companies, financial transparency*

JEL: G32, M41

Introduction

In the context of the intensification of global digital transformation processes, the role of information and communication technologies in enterprise management systems is becoming increasingly significant. Digitalization is rapidly reshaping the economic environment, influencing not only business models but also approaches to data processing, analysis, and decision-making. As a result, traditional methods of financial analysis are undergoing substantial transformation, integrating advanced digital solutions that enhance analytical capabilities.

The growing complexity of economic processes and the increasing volume of financial data necessitate the use of modern digital tools that enable efficient data processing, storage, and analysis.

In this regard, financial analysis is no longer limited to standard calculation procedures but is evolving into a dynamic and technologically driven process that supports strategic management decisions.

This issue is particularly relevant for joint-stock companies, whose operational activities are characterized by complex organizational structures, diversified business operations, and significant financial flows. In addition, such companies face increased requirements for transparency, accountability, and information disclosure to shareholders, investors, and other stakeholders. Under these conditions, financial reporting serves as a key source of information for assessing the financial condition, performance results, and future development prospects of enterprises.

The analysis of financial statements plays a crucial role in ensuring effective enterprise management. It enables the evaluation of essential financial indicators, such as liquidity, solvency, financial stability, and profitability, which collectively determine the level of financial sustainability and operational efficiency. These indicators form the basis for both internal management decisions and external assessments by investors and analysts.

At the same time, the traditional approaches to financial analysis are increasingly being complemented and enhanced by digital technologies. The use of modern digital tools, including spreadsheet software, business intelligence systems, and data analytics platforms, allows for the automation of analytical procedures, integration of diverse data sources, and real-time monitoring of financial performance.

Furthermore, digitalization contributes to improving the quality of financial analysis by enabling deeper insights, advanced forecasting, and more accurate identification of financial risks and opportunities. It also enhances the visualization of analytical results, making financial information more accessible and understandable for stakeholders.

Therefore, the study of digital tools in financial statement analysis is of particular scientific and practical importance. It allows for the identification of current trends in the development of financial analytics and provides a foundation for improving enterprise management in the digital economy.

Basic content

Financial statement analysis represents a fundamental component of the enterprise management system, ensuring the formation of an objective and comprehensive evaluation of financial performance. It serves as an essential instrument for supporting both strategic and operational decision-making processes.

Through the application of analytical procedures, it becomes possible to identify key development trends, assess financial risks, and determine potential areas for improving operational efficiency. For joint-stock companies, such analysis acquires particular importance due to the necessity of ensuring transparency, minimizing information asymmetry, and maintaining investor confidence.

The principal directions of financial analysis encompass liquidity assessment, solvency evaluation, financial stability analysis, and profitability measurement. The integrated application of these analytical dimensions enables a holistic evaluation of the enterprise's financial condition and facilitates the formulation of substantiated managerial decisions [1].

The evolution of digital technologies has led to a substantial transformation of traditional approaches to financial analysis. Modern digital tools significantly enhance analytical capabilities by enabling the automation of calculations, integration of heterogeneous data sources, and real-time processing of financial information.

The analysis of financial statement is an important component of the management decision-making process, as it enables an assessment of the business's performance in terms of resource allocation and financial stability. Through analytical processes, it is possible to identify key trends in the business's development, assess risks and identify potential opportunities for improving operational efficiency [2].

Traditional methods of economic analysis are being gradually supplemented by modern digital technologies, which enable the automated processing of large quantities of data and improve the accuracy of analytical assessments. A wide range of digital tools are now commonly used in financial analysis to integrate financial data and optimise analytical processes.

The most commonly used digital tools in financial analysis are table processors, in particular Microsoft Excel and Google Sheets. These tools provide extensive functionality for the automated calculation of financial indicators, significantly reducing the time required for data processing and minimizing the risk of human error. They enable the creation of structured analytical tables, dynamic reports, and dashboards that facilitate a comprehensive assessment of a company's financial position. In addition, spreadsheet software supports the development of complex financial models, including budgeting models, investment appraisal models, and scenario analysis. Through the use of built-in functions, formulas, and data analysis tools, analysts can perform sensitivity analysis, evaluate different financial scenarios, and forecast future business performance under varying assumptions.

Another important advantage of these tools is their ability to integrate data from multiple sources, ensuring consistency and accuracy in financial analysis. Google Sheets, in particular, enhances collaboration by allowing multiple users to work simultaneously on the same document in real time, which is especially valuable for team-based analytical processes.

An increasingly important role in modern financial statement analysis is played by business intelligence (BI) systems, such as Microsoft Power BI, Tableau, and Qlik Sense. These digital solutions represent a qualitatively new stage in the development of financial analytics, as they transform traditional static reporting into dynamic, interactive analytical environments.

The application of BI systems enables the integration of data from multiple internal and external sources, ensuring the creation of a unified analytical space for processing financial information. Through advanced data modeling and visualization tools, these platforms facilitate the development of interactive dashboards that allow users to monitor key financial indicators in real time, identify hidden patterns, and detect deviations from planned performance.

The Role of Business Intelligence Systems in Financial Analysis

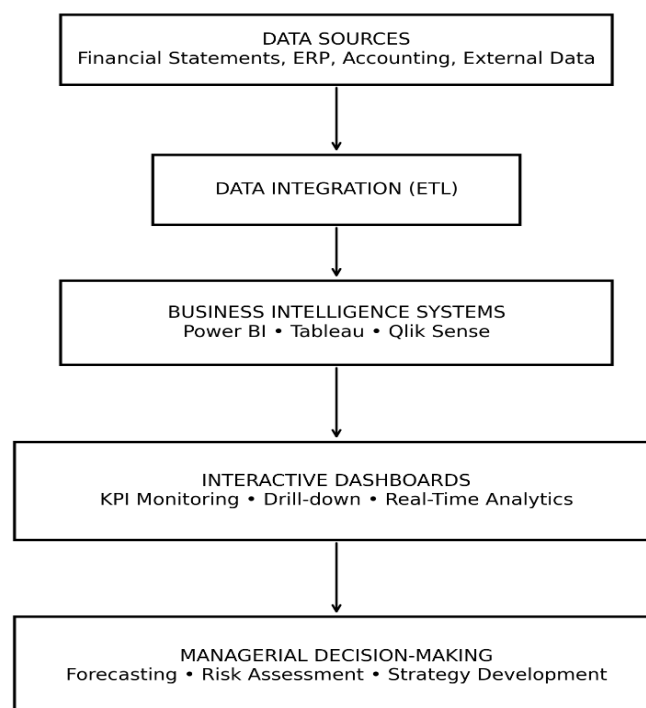


Figure 2. The role of Business Intelligence systems in financial analysis

Source: developed by the author

As illustrated in Figure 2 demonstrates the logical sequence of integrating business intelligence systems into the financial analysis process of joint-stock companies. At the initial stage, financial and operational data are collected from various internal and external sources, including financial statements, accounting systems, ERP platforms, and market data. Subsequently, the collected information undergoes integration and transformation through ETL (Extract, Transform, Load) procedures, ensuring data consistency and analytical readiness.

At the next stage, business intelligence systems such as Power BI, Tableau, and Qlik Sense process the integrated data and transform it into interactive analytical dashboards. These dashboards provide real-time monitoring of key performance indicators, support multidimensional drill-down analysis, and facilitate prompt identification of deviations and trends in financial performance.

Thus, business intelligence systems not only improve the visualization and accessibility of financial data but also form the basis for a new paradigm of data-driven financial management, which enhances the overall efficiency, transparency, and competitiveness of joint-stock companies in the digital economy.

In addition, modern trends involve the use of big data analytics tools. Programming languages such as Python are increasingly utilized in financial analysis due to their flexibility, scalability, and broad range of analytical libraries. These tools support statistical analysis, econometric modeling, forecasting of financial indicators, and the development of predictive algorithms for evaluating future business performance [3].

The application of digital tools in financial analysis and their impact on managerial decision-making are illustrated in Figure 2.

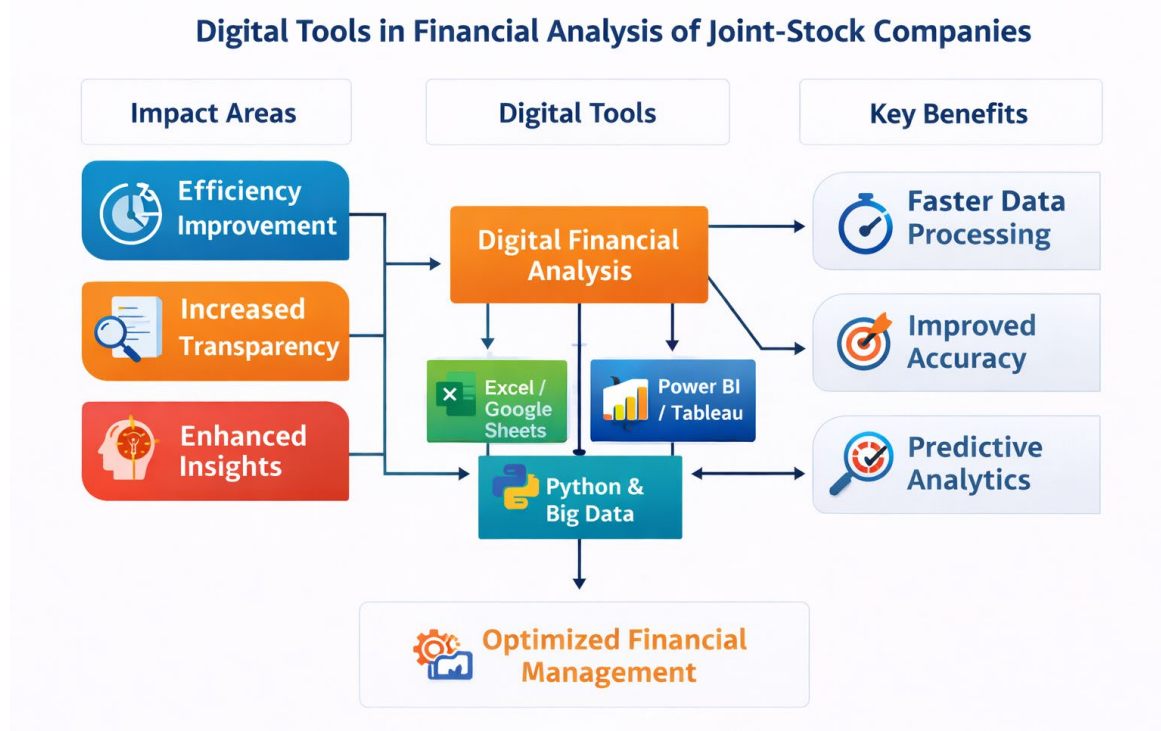


Figure 2. Digital tools in financial analysis of joint-stock companies

Source: developed by the author

The integration of digital technologies into financial analysis processes generates a range of significant advantages that contribute to improving the overall effectiveness of enterprise management.

Firstly, the automation of analytical procedures reduces the probability of human error and ensures a higher level of accuracy in calculations. Secondly, the high speed of data processing allows for the execution of real-time analysis, which is critical in a dynamic business environment.

Additionally, digital tools facilitate the processing of large datasets, enabling the application of Big Data analytics techniques. Enhanced visualization capabilities contribute to a better understanding of financial information and support more effective communication of analytical results to stakeholders. One of the most significant outcomes of the digitalization of financial analysis is the enhancement of transparency and accessibility of financial information. Digital tools ensure the structured presentation and efficient dissemination of financial data, thereby reducing information asymmetry between management and stakeholders.

For joint-stock companies, transparency constitutes a critical determinant of investor confidence and corporate reputation. The availability of accurate, timely, and comprehensible financial information contributes to more informed investment decisions and strengthens the overall governance framework.

Also, digital tools substantially improve the quality and efficiency of managerial decision-making processes. By providing access to real-time analytical data and advanced forecasting models, these tools enable managers to respond promptly to changes in the external environment and to develop well-grounded strategic initiatives.

Despite the substantial benefits associated with the implementation of digital technologies, several challenges and limitations must be taken into account.

Among the primary challenges are the high costs associated with the acquisition and maintenance of digital systems, as well as the necessity for highly qualified personnel capable of effectively utilizing these technologies. Furthermore, issues related to data security and confidentiality represent a critical concern in the context of increasing digitalization.

Another significant challenge involves the integration of new digital solutions with existing information systems, which may require substantial organizational and technical efforts.

Addressing these challenges necessitates the development of comprehensive digital transformation strategies and the implementation of appropriate risk management mechanisms.

Conclusions

The conducted study confirms that digital tools play a pivotal role in enhancing the effectiveness of financial statement analysis in joint-stock companies. The integration of modern digital technologies into analytical processes significantly improves the accuracy, efficiency, and depth of financial analysis, thereby increasing the quality of managerial decision-making and strengthening enterprise competitiveness in the digital economy.

The research demonstrates that the use of spreadsheet software, business intelligence systems, and programming tools enables enterprises to process substantial volumes of financial data, automate analytical procedures, and apply advanced methods of statistical and predictive analysis. In particular, business intelligence platforms improve the visualization and accessibility of financial information, while programming tools provide opportunities for implementing predictive analytics and econometric modeling.

Furthermore, digitalization contributes to increasing the transparency and reliability of financial reporting, which is especially important for joint-stock companies due to their obligations toward shareholders, investors, and other stakeholders. Enhanced transparency reduces information asymmetry, strengthens investor confidence, and improves the overall quality of corporate governance.

At the same time, the effective implementation of digital tools requires enterprises to overcome several challenges, including technological integration issues, cybersecurity risks, implementation costs, and the need for qualified personnel with advanced digital competencies.

Overall, the findings indicate that the adoption of digital analytical technologies should be regarded as a strategic priority for joint-stock companies seeking sustainable development, improved financial management, and long-term competitive advantages in the rapidly evolving digital environment.

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THE SUSTAINABLE COMPANY IN THE ACADEMIC LITERATURE: A BIBLIOMETRIC ANALYSIS

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Abstract: *Objective: The sustainable company has drawn considerable interest over time as shown by the dataset that contains research papers spanning from 1982 to 2026. The objective of this article is to present a comprehensive overview of this subject and its evolution over time.*

Methodology: A bibliometric analysis is performed on the Web of Science database. No time filter was applied and 5563 articles from business-related categories were analyzed using Bibliometrix, a package of R Studio.

Findings: The first papers were published between 1980-2000 and analyzed the corporate accountability for the social and physical environment, while exploring frameworks for creating sustainable companies. Over the next two decades, the focus shifted to sustainable business models, financial impact and company-level strategies. After COVID-19 crisis, sustainable supply chain management, circular economy, green innovations and ESG performance gained more interest, representing possible directions of future research. The main keywords cluster presents the close link between sustainability, performance, management and innovation. Performance is the theme that draws the most interest, being one of the most used keywords. The second cluster indicates the importance of governance in reaching social and environment objectives while the last one mentions the importance of SDGs and ethics within the CSR activities. The research is fragmented, both in the analyzed themes and in the author's collaboration network, with the EU countries being one of the biggest producers of cited research papers next to USA, China and UK.

Keywords: *sustainable company, sustainability, bibliometric analysis, corporate sustainability*

JEL: M140

Introduction

At international level, the global economy is facing significant climate and social challenges that require the incorporation of sustainability principles into management strategies. The concept of sustainable company gained significant attention from the business environment, covering all industries and organization sizes, from global corporations down to small and medium enterprises. Also, the term is widely used in policy contexts and third-sector organizations.

The introduction of new regulations that require sustainability reporting (as Global Reporting Initiative Standards and Corporate Sustainability Reporting Directive) has resulted in a higher interest for understating what is a sustainable company and how to measure its sustainability level.

Defining a sustainable company is a heated subject that is often debated because choosing just one definition is a challenge both for the academic and the business environment (as mentioned in the studies of Janowski (2020), Lankoski (2016) and Turker 2018 as cited in Thammaraksa, C. et al., 2025). However, the shared foundation claims that a company is responsible both for its economic gains as well as achieving social and environmental goals, such as protecting the environment and promoting social justice (Cantele *et al.*, 2024).

Business ethics plays a central role in reshaping how companies are managed by supporting decisions that prioritize moral considerations over profit maximizations and translating the abstract concept of sustainability into actionable practices. Without an ethical framework, sustainability becomes a superficial practice (Filho et al., 2024).

The existing bibliometric analyses cover a wide range of topics related to the sustainable company. Some research papers regarding the definition methods (Cantele, S., Landi, S., Vernizzi, S., 2024; Li, L., Lemke, F., 2025, Thammaraksa, C. et al. 2025) mention the complexity of concept, the lack of consensus around the definition and different frameworks that could be used to define the sustainability level.

Thammaraksa, C. et al. 2025 noted that corporate sustainability is a complex concept that can be understood through an interdisciplinary approach (economics, sociology, environmental studies, management, etc.). Moreover, the definition should be extended to include macro level concepts and the time dimension, because the meaning of sustainability evolves over time.

Cantele et al., 2024 mentions the lack of common definitions and indicators which affects comparability across firms and industries. Moreover, the framework that has been created removes the limitation of the three-dimensional concept (people, plant, profit) by adding „governance” as the new dimension.

Other bibliometric reviews are analyzing how corporate sustainability is implemented in supply chains companies or various sectors such as finance, industry, energy, agriculture, etc. Also, because the scope of the sustainability practices expended beyond large corporations, other reviews are focused on smaller organizations, like family-owned business (Häußler and Ulrich, 2024; Aparicio and Iturralde, 2023) or SMEs (Oduro and Haylemariam, 2025). These papers examine emerging challenges, determinants of sustainable strategies implementation and the resulting impact on competitiveness. Also, recent findings show a strong link between the SMEs and the circular economy (Malla and Zdziarski, 2025).

Considering the fragmented research, the objective of this paper is to conduct a bibliometric analysis to present an overview of the sustainable company. This paper will facilitate the comprehension of this subject and how it evolved over time from a business point of view. To reach this objective, this article aims to answer the following research questions:

RQ1: Which are the main characteristics of the academic literature regarding the sustainable companies?

RQ2: Which are the main authors and journals that influenced the research?

RQ3: Which is the geographical distribution of the knowledge?

RQ4: How has research progressed during the time?

To answer these questions, a bibliometric analysis will be performed based on the Web of Science database. The paper is divided in three chapters. The first chapter presents the literature review related to the sustainable company, the second one describes the research methodology and the last one highlights the conclusions.

Literature Review

Choosing just one way to define the sustainable company is a challenge for researchers due to different theoretical approaches, conflicting definitions and the evolving sustainability context (Thammaraksa et al., 2025).

Theoretical approaches are fragmented because each theory emphasizes a specific dimension of sustainability. For example, the stakeholder theory highlights the importance of integrating the interests of all actors affected by the activity of an organization, no matter if the impact is direct or indirect. Institutional theory and legitimacy theory support the alignment between corporate goals and society norms while the natural resource-based view is focusing on proper management of a company's resources (Lozano et al., 2015).

Over the years, the term sustainability evolved from a simple concern for the conservation of the environment to a multidimensional framework that includes economic, social and governance dimensions. If in the 1970s the sustainability meant only environment protection and pollution reduction, the Brundtland Report from 1987 introduced the central idea of a sustainable development

that „meets the needs of the present without compromising the ability of future generations to meet their own needs”.

As business ethics evolved from a mere reasonability towards shareholders to a larger vision including the social and ecological impact, the Triple Bottom Line Theory was developed to analyze a company from three perspectives: Profit, People, Planet. Therefore, the companies started transitioning from a traditional business model focused only on profit, to a sustainable business model which aims to reach economic, social and environmental goals at the same.

However, defining sustainability based on the Triple Bottom view is not sufficient, because it is omitted an essential element: corporate governance (Cantele *et al.*, 2024). Corporate governance represents the system that drives and controls a company having as main objective its efficient management (G20/OECD Principles of Corporate Governance 2023). Therefore, mismanagement can lead to insufficient transparency and accountability towards the stakeholders.

Moving forward, recent literature and European Sustainability Reporting Standards increasingly refer to ESG approach (environment, social, governance). This evolution leads to a reclassification of some aspects from the social and economic areas to the governance domain (Cantele *et al.*, 2024).

The meaning of the concept has been influenced by the international standards, which defined expectation and companies demands. The regulations have become stricter and standards as The Paris Agreement (2015) enforce specific measures to combat climate change while Corporate Sustainability Reporting Directive demands companies to report their impact on the environment and society at large.

In the same time, global crisis (the COVID-19 pandemic, wars, etc.) highlighted the limits of the traditional systems and showed the need of a sustainable development. Short supply chains and circular economy gained more interest, while green technologies and recycled materials created new business models. As mentioned in the European Parliament in the Report on the trade-related aspects and implications of COVID-19 (2021), the crisis showed vulnerabilities in the supply chains of some critical raw materials and medical goods. The report also mentioned the importance of having sustainable value chains because the existing structure causes asymmetrical effects (risks are distributed uneven, affecting mostly the least developed countries).

The United Nations 2030 Agenda for Sustainable Development, adopted in 2015, had a major impact on the corporate sustainability. The 17 Sustainable Development Goals (SDGs) become a benchmark in implementing strategies aimed at reducing poverty, protecting the environment and promoting social inclusion (The Sustainable Development Goals Report, 2025). Multinational companies are encouraged to adopt sustainable practices and to submit sustainability reports. Additionally, by disclosing outcomes related to the SDGs, firms enhance their reputation and differentiate their brand in the global market (Filho *et al.*, 2024).

The most recent literature presents the sustainable company through the economic, social and environmental perspectives. Thus, the economic sustainability of a company means that it can ensure both long term and short-term stability, while aligning with the SDGs. Social sustainability refers to a company's ability to address stakeholders needs and conforming to societal norms, whilst environmental sustainability represents the commitment to conserve the resources of the company (Thammaraksa *et al.*, 2025).

Research Methodology

As mentioned by Donthu *et al.*, (2021) a bibliometric analysis is recommended when a substantial amount of data is available because it helps to summarize the information and analyze the core themes and emerging trends within a research field. When searching on Web of Science papers related to sustainable companies in English with filter on Web of Science Categories such as Business, Management, Economics or Business Finance, 5563 results are returned therefore a bibliometric analysis can be applied. The search was based on the following query:

Query: (TI=(sustainab)) AND (TI=(corporat*) OR TI=(compan*) OR TI=(business*) OR TI=(sme))*

The terms were selected to include a wide range of articles that combine the concept of sustainability with businesses, regardless of their size (corporation, SME, company). The asterisk was used to include other terms relevant for the research that can be used as substitutes (e.g.: sustainable business vs. business sustainability).

To perform the analysis, all the 5563 academic publications mentioned above were included in the study. The collected data was analyzed using the Bibliometrix package of R Studio, an open-source tool used to perform comprehensive science mapping analysis (Aria and Cuccurullo, 2017).

Results and discussion

The sustainable company has drawn considerable interest from researchers over time, as shown by the dataset that contains studies spanning four decades (1982 - 2026). The first article was published in 1982 by A. Crouter and J. Garbarino (US) in the Technological Forecasting and Social Change Journal; it discusses the relationship between a sustainable society and corporate accountability for the social and physical environment while proposing strategies for the development of corporate self-reliance.

Since then, the number of publications increased each year, recording a sharp increase in 2025. The 2026 data include only the first trimester of the year and already shows a significant number of published papers.

Below are presented the findings of the bibliometric analysis, starting with the evolution of scientific production and continuing with the most important journals and researchers, keywords analysis and future research directions.

The scientific production increased slightly between 1990 and 2000; even if there were few publications available, those represented the foundation of future research recording the highest average citation (as shown in Table 1).

In the coming years, research on sustainable companies is gaining more interest, with visible increase in the number of published works. However, the average citation per article decreased, suggesting a research pattern focused on specific themes, evolving from general sustainability concepts to investigations adapted to business level

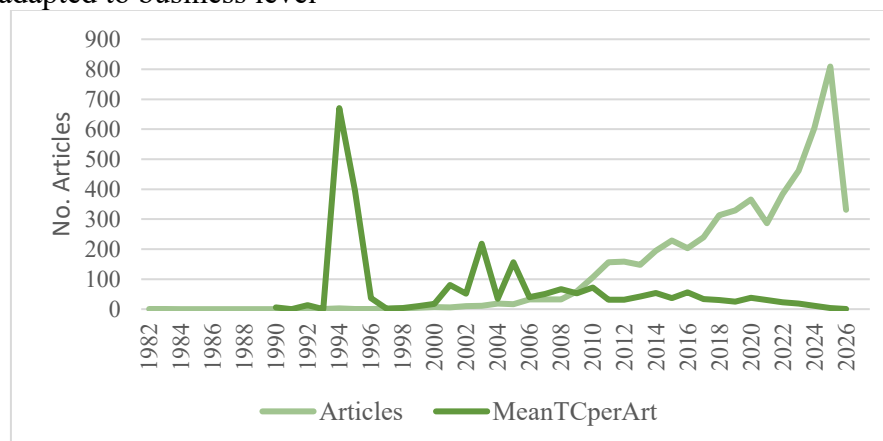


Figure 1. Evolution of Scientific Production

Source: Author's own work

The research papers are spread across multiple publications (as seen in Table 2) and the top 3 most important journals (Business Strategy and The Environment, Corporate Social Responsibility and Environmental Management, Journal of Business Ethics) account for only 15% of written articles. This indicates that the research field is diverse, as shown by the journal titles (Environment, Social, Business, Ethics, Law, etc).

Table 1. Top 10 most important journals

Sources	Articles	Percentage
BUSINESS STRATEGY AND THE ENVIRONMENT	405	7%
CORPORATE SOCIAL RESPONSIBILITY AND ENVIRONMENTAL MANAGEMENT	313	6%
JOURNAL OF BUSINESS ETHICS	124	2%
COGENT BUSINESS & MANAGEMENT	65	1%
CORPORATE GOVERNANCE-THE INTERNATIONAL JOURNAL OF BUSINESS IN SOCIETY	64	1%
BUSINESS STRATEGY AND DEVELOPMENT	63	1%
SOCIAL RESPONSIBILITY JOURNAL	59	1%
ORGANIZATION & ENVIRONMENT	57	1%
AMFITEATRU ECONOMIC	50	1%
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	44	1%

Source: Author's own work

The network of the most important researchers (Table 3) shows a high research fragmentation, with limited collaborations. Schaltegger S. and Svensson G. rank among the leading researchers covering sustainable business models, implementation frameworks and resulting impacts.

The countries that provide the most cited papers are from European Union (Germany, Italy, Netherlands, Spain, France, Romania, etc), USA, UK and China. The high interest of the European research on the sustainable development of companies can be explained by various directives and regulations that have been implemented such as Green Deal, Corporate Sustainability Reporting Directive, etc.

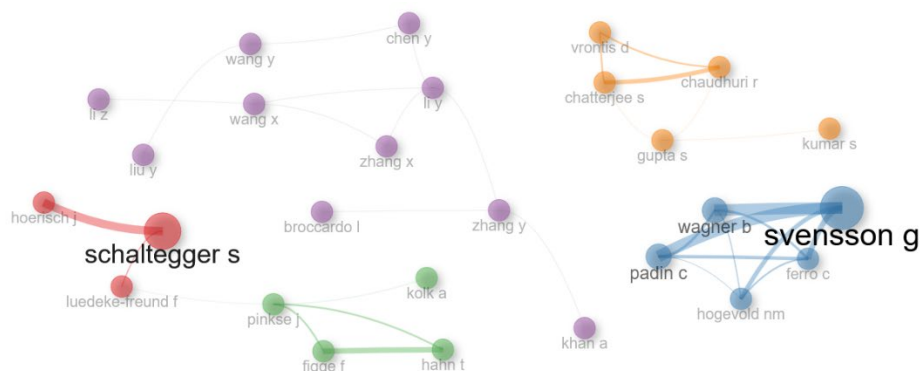


Figure 2. The network of the most important researchers

Source: Bibliometrix

The analysis of keywords frequency shows the research priorities of the field and the structure of the topics that have been covered (Table 4). Thus, most articles show a high focus on topics related to performance, developing innovative strategies and improving management policies. The data reveals that “performance” is the theme that draws the most interest, being one of the most used keywords. Subsequently, the association with “impact” and “determinants” shows the companies’ tendency to perceive sustainability mainly from a financial perspective.

Afterwards the focus is placed on social and environment dimensions, indicating the important role of the governance in the corporate social responsibility (CSR) activities. Keywords related to firm-level sustainability show the highest degree of fragmentation. Terms like “firm” or “company” are frequently used in relation to business sectors (e.g. industry), circular economy, supply chain,

reporting and entrepreneurship development models. Also, keywords as “green”, “quality” and “strategies” occur due to the necessity of identifying new sustainable solution.



Figure 3. Tree map of keywords frequency

Source: Bibliometrix

The analysis of the clusters created by the co-occurrence network provides complementary insights on the themes that were identified. The network includes three main clusters (Table 5). The principal cluster is the red one and presents the close link between sustainability, management, performance and innovation. The research includes frameworks and strategies for sustainable development, in close connection to business activity.

The blue cluster demonstrates as well that governance is a key driver for achieving social and environmental objectives, while playing a central role in the ESG disclosure process and sustainability reporting. The complex role is explained through stakeholder theory that argues that a company should consider the interests of all actors affected by the activity of an organization. Legitimacy theory is another perspective use to explain the governance importance by aligning corporate goals with societal expectations.

The last cluster (green) links the corporate social responsibility (CSR) to stakeholders and sustainable development. In this area, the influence of UN’s Sustainable Development Goals (SDGs) and the role of ethics and education are enabling the transition toward a sustainable business model.

The historical evolution of the co-occurrence Network provided by Bibliometrix shows that in 2000’s the first cluster was formed around the link between sustainability and performance. By 2010, the second cluster related to social responsibility emerges and the research papers are focusing on sustainability reporting and the role of governance. The core cluster related to sustainable development extends to industry and supply chain management, while green innovation is on the rise. Everything consolidates until 2020. After COVID-19, the circular economy and ESG performance emerge as new concepts, representing possible directions of future research.

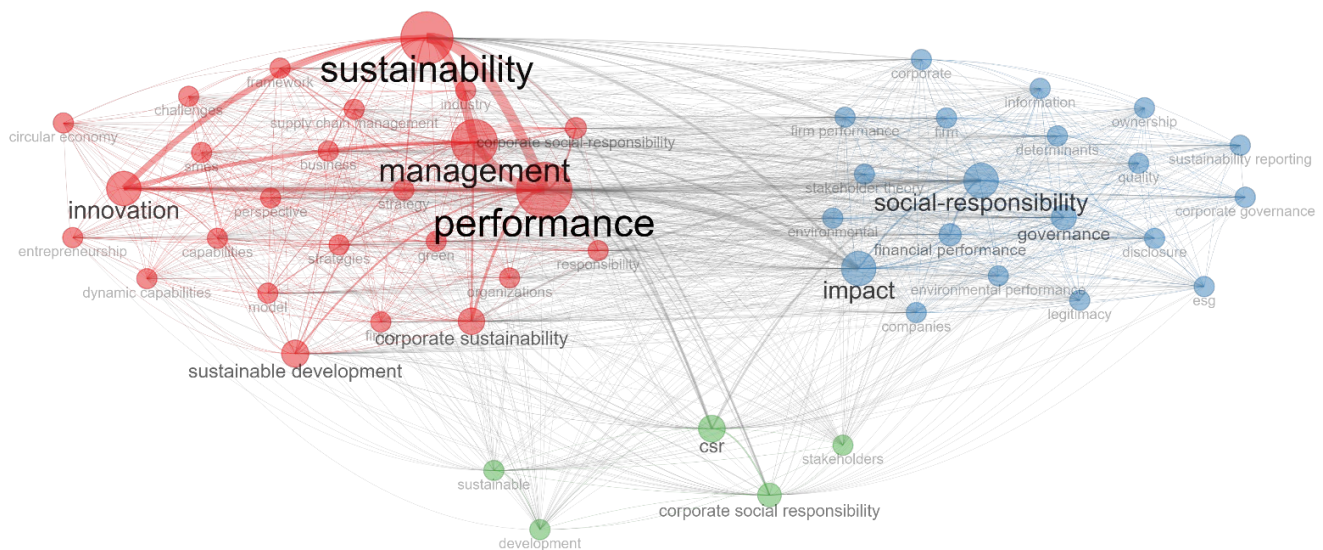


Figure 4. Co-occurrence network

Source: Bibliometrix

Conclusions

Considering the high interest related to the sustainable companies, this article presents a bibliometric analysis of the existing academic literature. The objective of this paper is to provide a comprehensive overview of the subject and its evolution over time, from a business perspective.

Based on the keyword co-occurrence network, the findings show three clusters of data. The first cluster is the most important one and presents the close link between sustainability, management, performance and innovation. The data shows that “performance” is the theme that draws the most interest, being one of the most used keywords. The second cluster indicates the importance of governance in reaching social and environment objectives while the last one mentions the role of SDGs and ethics in the accomplishment of the CSR activities.

The first cluster was formed between 1982 - 2010 and is focusing on finding the strategies that could lead to a sustainable company. Over the next two decades, the focus shifted to sustainable business models, implementation frameworks, financial impacts and company-level strategies. After 2020, concepts as sustainable supply chain management, circular economy, green innovations and ESG performance gained more interest, representing possible directions of future research.

The findings also show fragmented research, both in the analyzed themes and in the author’s collaboration network. The geographical distribution of the knowledge shows that EU countries (Germany, Italy, Netherlands, Spain, France, Romania, etc) are one of the biggest producers of cited research papers next to USA, China, UK and India. Schaltegger S. and Svensson G. rank among the leading researchers covering sustainable business models, implementation frameworks and resulting impacts. The research papers are spread across multiple publications and the top 3 most important journals (Business Strategy and The Environment, Corporate Social Responsibility and Environmental Management, Journal of Business Ethics) account for only 15% of the academic literature, indicating that the sustainable companies are analyzed thought diverse perspective, such as Environment, Social, Business, Ethics, Law, etc.

This article has limitations because the bibliometric analysis includes only papers written in English from Web of Science, which may overlook another relevant research. As seen, the meaning of a sustainable company is evolving over time, therefore a periodic reassessment is recommended.

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FINANCIAL PERFORMANCE AND RISK DYNAMICS: EVIDENCE FROM BVB LISTED COMPANIES

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Abstract: *This study examines the relationship between financial performance and corporate risk among companies listed on the regulated market of the Bucharest Stock Exchange (BVB) between 2019 and 2024. The main objective is to evaluate the influence of bankruptcy risk indicators (Altman Z-score and Conan & Holder model), liquidity ratios (current ratio and quick ratio), financial leverage, and stock returns on financial performance, as measured by return on assets (ROA) and return on equity (ROE).*

The methodological framework incorporates distribution analysis and correlation analysis using Pearson, Spearman and Kendall coefficients, as well as linear regression models to evaluate the explanatory power of risk and liquidity indicators on financial performance.

The results suggest that ROA is more closely linked to fundamental financial conditions than ROE, as it exhibits stronger and more consistent relationships with financial stability and liquidity indicators. In contrast, ROE appears less predictable, reflecting the influence of firm-specific financial policies. Regression analysis reveals moderate explanatory power, with significant relationships emerging only during specific periods, particularly in the post-pandemic context. Furthermore, stock returns demonstrate weak and unstable connections with accounting performance, emphasising the impact of market inefficiencies.

Overall, the findings emphasise the dynamic and context-dependent nature of the relationship between performance and risk in an emerging market environment.

Key words: *Financial performance, Bankruptcy risk, Liquidity, BVB, Linear regression, Correlation analysis*

JEL: G32, G33, G30.

Introduction

The relationship between financial performance and corporate risk is a central topic in financial theory and practice, and is essential for understanding the mechanisms that determine firm value and investor behavior. Classic performance indicators, such as Return on Equity (ROE) and Return on Assets (ROA), are widely used to assess the efficiency of capital and asset utilization, but their ability to explain stock market returns and reflect companies' actual risk remains a hotly debated topic in the literature.

In the context of emerging markets, this relationship becomes even more complex, as macroeconomic factors, low liquidity, and information imperfections can amplify the discrepancies between accounting and market performance. Empirical studies show that profitability indicators are positively correlated with market value and stock returns, but this relationship is significantly influenced by the level of financial risk and the stability of the company (Arkan, 2016).

In this context, bankruptcy prediction models, such as the Altman Z-score and the Conan and Holder score, play a crucial role in corporate risk assessment. The literature highlights that these models are not only early warning tools but also relevant indicators of financial performance and long-term stability (Ogachi et al., 2020).

Furthermore, liquidity indicators and capital structure significantly influence firm performance. Empirical studies indicate the existence of a complex relationship between liquidity and profitability, where high levels of liquidity can reduce the efficiency of resource utilization, while excessive financial leverage can amplify the risk of bankruptcy (Musah & Kong, 2019; Akhtar et al., 2022).

Regarding the relationship between financial performance and stock returns, research shows that accounting indicators such as ROE and ROA can positively influence stock returns, but this relationship is mediated by factors such as firm size, liquidity, and risk perceived by investors (Chabachib & Setyaningrum, 2020).

In the case of Romania, the capital market exhibits characteristics specific to an emerging economy, characterized by a relatively small number of listed companies, limited liquidity, and high sensitivity to external factors. These characteristics make the analysis of the relationship between performance, risk, and stock market returns particularly relevant, offering important insights into market efficiency and investor behavior.

Therefore, the objective of this study is to analyze the relationship between financial performance (ROE, ROA), corporate risk (Altman Z-score, Conan and Holder score, liquidity, and financial leverage), and stock market returns for a sample of 50 companies listed on the Bucharest Stock Exchange. The study aims to highlight both the strength and the direction of these relationships using robust statistical methods and to contribute to the understanding of the mechanisms that determine financial performance in an emerging market context.

Basic content.

Analysis of the distribution of indicators

To highlight the dynamics of financial performance and corporate risk among companies listed on the Bucharest Stock Exchange, the analysis was expanded to examine the distribution of firms across relevant intervals of key indicators over the 2019–2024 period. This approach allows not only for the observation of average values but also for an understanding of the internal structure of the sample and the degree of polarization of performance and risk.

Regarding **return on assets (ROA)**, the distribution of firms indicates a persistent concentration in the lower range, namely 0%–5%, where the majority of companies are found in all the years analyzed. This structure suggests a moderate level of efficiency in the use of assets, typical of emerging markets. At the same time, there was an increase in the number of companies with negative ROA in 2020, amid the economic shock caused by the COVID-19 pandemic, followed by relative stabilization in the subsequent period. The segment of high-performing firms (ROA > 15%) remains small in size but shows a slight upward trend in the post-pandemic years, indicating a gradual consolidation of high-performing companies.

Table 1. Distribution of Companies by Financial Performance Indicators

Indicator	Interval	2019	2020	2021	2022	2023	2024
ROA	<0%	10	16	12	9	13	12
ROA	0%<x<5%	25	19	19	20	18	20
ROA	5%<x<15%	13	13	15	15	14	13
ROA	>15%	2	2	4	6	5	5
ROE	<0%	8	14	11	10	12	13
ROE	0%<x<15%	35	29	33	28	27	32
ROE	15%<x<20%	2	3	1	3	4	3
ROE	>20%	5	4	5	9	7	2
Stock returns	<-15%		18	7	13	11	16
Stock returns	-15%<x<0%		6	5	21	3	9
Stock returns	0%<x<15%		12	13	8	11	11
Stock returns	>15%		14	25	8	25	14

Source: Author's own calculations based on data processed in Microsoft Excel

A similar pattern is observed for **return on equity (ROE)**, where most firms fall within the 0%–15% range, suggesting moderate and relatively stable profitability. The increase in the number of companies with negative ROE in 2020 reflects the direct impact of the economic crisis on financial results, but the subsequent recovery indicates the firms' ability to adapt. Additionally, there is a notable decrease in the share of firms with very high ROE (>20%) in 2024, which may suggest a moderation of exceptional performance and a convergence toward more sustainable levels.

An analysis of **stock returns** highlights a high degree of volatility, characteristic of emerging markets. The distribution of firms across intervals shows significant fluctuations from one year to the next, without a clear pattern of stability. In 2021 and 2023, there is an increase in the number of companies with high returns (>15%), which may reflect periods of investment optimism, while in 2020 and 2022 the distribution is more dispersed, indicating uncertainty and heterogeneous market reactions. This variability suggests that stock market returns are not determined exclusively by financial performance, but also by external and behavioral factors.

In terms of bankruptcy risk as measured by the **Altman Z-score**, most companies consistently fall within the safe zone ($Z \geq 3$), which indicates, at the aggregate level, a relatively high degree of financial stability. However, the presence of a significant number of firms in the risk zone (<1.8) highlights the heterogeneity of the sample and the existence of structural vulnerabilities. The trend in this indicator suggests a slight deterioration in stability in recent years, as evidenced by the increase in the number of firms in the risk zones.

Table 2. Distribution of Companies by Financial Risk, Liquidity and Leverage Indicators

Indicator	Interval	2019	2020	2021	2022	2023	2024
Altman	<1.8	10	11	8	6	11	10
Altman	$1.8 \leq x < 2.7$	9	9	9	11	12	12
Altman	$2.7 \leq x < 3$	3	4	3	6	3	4
Altman	≥ 3	28	26	30	27	24	24
Conan & Holder	<-0.3	3	4	2	2	3	2
Conan & Holder	$-0.3 \leq x < 0.04$	14	18	14	10	15	15
Conan & Holder	$0.04 \leq x < 0.2$	30	24	28	34	28	28
Conan & Holder	≥ 0.2	3	4	6	4	4	5
Current Ratio	<1	10	12	9	8	9	13
Current Ratio	$1 \leq x < 1.5$	9	8	5	10	10	4
Current Ratio	$1.5 \leq x < 2$	6	5	9	6	6	4
Current Ratio	≥ 2	25	25	27	26	25	29
Quick Ratio	<0.5	9	7	6	10	9	13
Quick Ratio	$0.5 \leq x < 1$	15	14	13	10	13	10
Quick Ratio	$1 \leq x < 1.5$	4	8	9	10	7	8
Quick Ratio	≥ 1.5	22	21	22	20	21	19
Financial Leverage	<1		18	19	16	19	18
Financial Leverage	$1 \leq x < 2$		26	29	27	25	28
Financial Leverage	$2 \leq x < 3$		5	1	3	4	1
Financial Leverage	≥ 3		1	1	4	2	3

Source: Author's own calculations based on data processed in Microsoft Excel

The **Conan and Holder** indicator confirms this picture, with most companies concentrated in the 0.04–0.2 range, corresponding to an intermediate risk zone. The relatively small number of firms in the high-risk zone (<-0.3) suggests that, although vulnerabilities exist, they are not dominant across the entire sample.

The liquidity analysis reveals a relatively balanced profile of the companies. In the case of the **Current Ratio**, most firms fall within the upper range (≥ 2), indicating a good ability to cover short-term obligations. However, the increase in the number of companies with sub-unit liquidity (< 1) in 2024 may signal the emergence of financial strains in the recent economic context. A similar trend is observed for the **Quick Ratio**, where the distribution indicates a polarization between firms with high liquidity and those below the optimal threshold, suggesting different working capital management strategies.

In terms of **financial leverage**, most companies fall within the 1–2 range, reflecting a moderate use of debt. The small number of firms with very high leverage (≥ 3) indicates a cautious approach to debt financing, typical of an economic environment characterized by uncertainty. At the same time, the presence of a significant number of companies with sub-unit leverage (< 1) suggests a preference for equity financing, which can contribute to financial stability but may limit the leverage effect on profitability.

Overall, the distribution of indicators highlights a financial profile characterized by moderate performance, controlled risk, and a tendency toward prudence in financial policies. Although there are signs of post-pandemic improvement, the heterogeneity of results and the volatility of stock market returns indicate that the Romanian capital market remains influenced by structural and cyclical factors specific to emerging economies.

Analysis of the Correlations Between Performance and Risk

To explore the relationship between financial performance and corporate risk, correlations between profitability ratios (ROE and ROA) and variables related to risk, liquidity, and market performance were analyzed using Pearson, Spearman, and Kendall coefficients. The results highlight both structurally consistent relationships and significant year-over-year variations, characteristic of an emerging market.

In the case of ROE, the relationship with bankruptcy risk indicators is uneven but shows clear trends in certain periods. The correlation with the Altman Z-score is generally positive, particularly for non-parametric coefficients (Spearman and Kendall), where the values are frequently statistically significant. This result suggests that financially more stable firms tend to generate higher returns on equity, but this relationship is not always captured by the linear correlation (Pearson), indicating possible nonlinear relationships or the influence of outliers. The strengthening of this link in 2023–2024 reflects market maturation and a better correlation between stability and performance.

Table 3. Correlation Analysis between ROE and selected risk indicators

ROE vs	Indicator	2019	2020	2021	2022	2023	2024
Altman	Pearson's r	0.013	0.087	-0.077	-0.2	0.361*	0.031
Altman	Spearman's rho	0.375**	0.285*	0.325*	0.114	0.385**	0.471***
Altman	Kendall's Tau B	0.263**	0.197*	0.224*	0.084	0.288**	0.332***
Conan & Holder	Pearson's r	-0.073	-0.159	0.365**	0.042	0.084	0.560***
Conan & Holder	Spearman's rho	0.334*	0.153	0.077	0.223	0.476***	0.430**
Conan & Holder	Kendall's Tau B	0.235*	0.118	0.061	0.169	0.337***	0.310**
Current Ratio	Pearson's r	0.125	0.123	-0.048	0.107	0.336*	0.051
Current Ratio	Spearman's rho	0.354*	0.271	0.224	0.209	0.21	0.414**
Current Ratio	Kendall's Tau B	0.255**	0.193*	0.149	0.141	0.156	0.284**
Quick Ratio	Pearson's r	0.081	0.124	-0.065	0.098	0.369**	0.038
Quick Ratio	Spearman's rho	0.345*	0.248	0.214	0.316*	0.342*	0.500***
Quick Ratio	Kendall's Tau B	0.237*	0.174	0.146	0.228*	0.236*	0.359***
Fin. Leverage	Pearson's r		0.154	0.016	0.061	0.052	0.019
Fin. Leverage	Spearman's rho		0.373**	0.320*	0.443**	0.321*	0.325*
Fin. Leverage	Kendall's Tau B		0.227*	0.163	0.245*	0.131	0.164
Stock return	Pearson's r		0.194	0.007	-0.419**	0.302*	0.01
Stock return	Spearman's rho		0.163	0.361**	-0.071	0.24	0.198
Stock return	Kendall's Tau B		0.123	0.266**	-0.057	0.167	0.14

Source: Author's own calculations using Jamovi software; data processed and organized in Microsoft Excel

The relationship between ROE and the Conan & Holder score has become more pronounced in recent years, particularly in 2023 and 2024, when all three types of correlations indicate positive and significant values. This trend suggests that alternative bankruptcy risk indicators are beginning to better capture companies' financial reality, providing a complementary view to the Altman model.

Regarding liquidity, both the Current Ratio and the Quick Ratio show positive but moderate correlations with ROE. These relationships are more evident in the Spearman and Kendall analyses, suggesting that firms with a better liquidity position tend to have superior performance as well, though this relationship is not a strong one. In recent years, particularly in 2024, the strengthening of correlations may indicate an increase in the importance of liquidity in a more uncertain economic context.

In contrast, financial leverage shows a weak relationship with ROE in the case of the Pearson coefficient, but becomes moderately positive in the case of the nonparametric coefficients. This result suggests that the use of debt can contribute to an increase in return on equity, but the effect depends on the specific structure of the firms and is not uniform across the entire sample.

The relationship between ROE and stock returns is characterized by high volatility and the absence of a stable pattern. Although there are episodes of positive correlation, these are inconsistent, and in certain periods, significant negative correlations even emerge (e.g., 2022 in the case of Pearson). This result suggests that, in the Romanian capital market, stock returns are not determined exclusively by accounting performance, but are also influenced by external factors, such as investor sentiment or macroeconomic conditions.

In the case of ROA, the results are more consistent and indicate stronger relationships with risk and liquidity indicators. The correlation with the Altman Z-score is consistently positive and significant for all methods, particularly for the Spearman and Kendall coefficients, where the values are high throughout the entire period analyzed. This result confirms that the efficiency of asset utilization is closely linked to the financial stability of companies.

Table 4. Correlation Analysis between ROA and selected risk indicators

ROA vs	Indicator	2019	2020	2021	2022	2023	2024
Altman	Pearson's r	0.106	0.18	0.063	0.333*	0.537***	0.076
Altman	Spearman's rho	0.624***	0.484***	0.518***	0.428**	0.581***	0.510***
Altman	Kendall's Tau B	0.443***	0.344***	0.375***	0.314**	0.440***	0.381***
Conan & Holder	Pearson's r	0.422**	0.350*	-0.024	-0.007	0.089	0.032
Conan & Holder	Spearman's rho	0.559***	0.357*	-0.004	0.045	0.448**	0.350*
Conan & Holder	Kendall's Tau B	0.389***	0.256**	0.012	0.04	0.326***	0.278**
Current Ratio	Pearson's r	0.334*	0.272	-0.111	-0.03	0.510***	0.109
Current Ratio	Spearman's rho	0.605***	0.480***	0.237	0.219	0.333*	0.443**
Current Ratio	Kendall's Tau B	0.431***	0.337***	0.172	0.153	0.252**	0.307**
Quick Ratio	Pearson's r	0.251	0.252	-0.103	-0.037	0.546***	0.106
Quick Ratio	Spearman's rho	0.538***	0.424**	0.327*	0.300*	0.455**	0.545***
Quick Ratio	Kendall's Tau B	0.394***	0.282**	0.231*	0.226*	0.339***	0.392***
Fin. Leverage	Pearson's r		0.117	-0.002	0.026	0.052	-0.023
Fin. Leverage	Spearman's rho		0.422**	0.379**	0.444**	0.344*	0.359*
Fin. Leverage	Kendall's Tau B		0.253**	0.183	0.237*	0.13	0.19
Stock return	Pearson's r		0.330*	0.192	0.941***	0.389**	-0.176
Stock return	Spearman's rho		0.178	0.421**	0.087	0.281*	0.168
Stock return	Kendall's Tau B		0.131	0.314**	0.052	0.202*	0.125

Source: Author's own calculations using Jamovi software; data processed and organized in Microsoft Excel

The relationship with the Conan & Holder score is also positive, but less stable over time, with significant values particularly in the first and last years of the analyzed period. This variation suggests that the sensitivity of the ROA indicator to bankruptcy risk depends on the economic context and the sectoral structure of the companies.

Liquidity ratios show positive and relatively strong correlations with ROA, particularly in the case of the Spearman coefficient. This result indicates that firms that manage working capital efficiently tend to use total assets more efficiently as well, generating higher returns. At the same time, this relationship has become more pronounced in recent years, suggesting an increase in the importance of liquidity in the post-pandemic economic context.

Similarly, financial leverage shows a moderate positive relationship with ROA in the nonparametric analysis, which may indicate that an optimal level of debt contributes to more efficient asset utilization without generating excessive risks.

Regarding the relationship between ROA and stock returns, the results are mixed and, in some cases, extreme, such as the very high Pearson coefficient in 2022. This anomaly suggests the presence of outliers or exceptional market events that distort the linear relationship. Overall, the correlations remain moderate and unstable, confirming that the market does not directly reflect firms' accounting performance.

Overall, the correlation analysis highlights that ROA is more closely linked to financial stability and liquidity than ROE, suggesting that operational efficiency is a more robust determinant of performance than return on equity. At the same time, the weak and volatile relationship between accounting indicators and stock market returns confirms the specific nature of an emerging market, where information transmission mechanisms are imperfect and investor behavior plays a significant role.

Analysis of Linear Regressions – Determinants of Financial Performance

To assess the explanatory power of risk and liquidity indicators on financial performance, linear regression models were estimated with ROA and ROE as dependent variables. The results highlight significant differences between the two dimensions of performance, both in terms of the relevance of the explanatory variables and the strength of the models.

In the case of **ROA**, the models exhibit moderate explanatory power, with values of the coefficient of determination (R^2) ranging from 0.02 to 0.328. It is noteworthy that the years 2019, 2022, and 2023 yield the most robust models, suggesting that during these periods, the companies' operational performance was better explained by the included variables.

Among the indicators analyzed, the Altman Z-score becomes relevant only in 2022, where the coefficient is positive and statistically significant, and the standardized coefficient value indicates a moderate impact on ROA. This result suggests that, in a more stable post-pandemic economic context, the risk of bankruptcy begins to directly influence the efficiency of asset utilization. For the remainder of the period, the influence of this indicator remains insignificant, indicating a context-dependent relationship.

Table 5. Determinants of ROA: Linear Regression Results

ROA vs	Indicator	2019	2020	2021	2022	2023	2024
Altman	Estimate	0.000	-0.001	0.001	0.051	0.002	0.000
Altman	Stand. Estimate	-0.106	-0.111	0.051	0.564	0.248	-0.062
Altman	p	0.652	0.652	0.747	0.001	0.399	0.832
Conan & Holder	Estimate	0.183	0.087	0.008	0.004	0.002	0.002
Conan & Holder	Stand. Estimate	0.366	0.339	0.941	0.029	0.074	0.019
Conan & Holder	p	0.009	0.019	0.012	0.831	0.552	0.902
Current Ratio	Estimate	0.007	0.001	-0.008	0.051	-0.014	0.001
Current Ratio	Stand. Estimate	0.473	0.069	-0.722	1.891	-0.621	0.224
Current Ratio	p	0.148	0.880	0.658	0.035	0.309	0.815
Quick Ratio	Estimate	-0.003	0.005	0.008	-0.093	0.022	0.000
Quick Ratio	Stand. Estimate	-0.189	0.253	0.608	-1.995	0.925	-0.064
Quick Ratio	p	0.656	0.648	0.709	0.028	0.168	0.946
	R ²	0.254	0.181	0.020	0.205	0.328	0.014
	Adjusted R ²	0.187	0.108	-0.067	0.134	0.268	-0.074

Source: Author's own calculations using Jamovi software; data processed and organized in Microsoft Excel

The Conan & Holder score plays a significant role in the early years of the analysis, particularly in 2019 and 2020, when the coefficients are positive and statistically significant. In 2021, a very high standardized value appears, but this should be interpreted with caution, as it suggests possible distortions caused by outliers or the sample structure. In subsequent years, the relevance of this indicator declines significantly, indicating a decrease in its predictive power regarding performance. Regarding liquidity, the results are mixed. The Current Ratio becomes significant only in 2022, where its positive impact on ROA is evident, suggesting that working capital management was an important factor that year. However, the high standardized values indicate possible instability in the estimates, which requires careful interpretation. The Quick Ratio also shows a significant effect in 2022, albeit a negative one, which may suggest an excess of immediate liquidity associated with inefficient use of resources.

Overall, the results for ROA indicate that no single indicator has a consistent influence throughout the entire period, but at specific points in time (particularly 2022) the relationships become significant, reflecting the sensitivity of operational performance to economic conditions.

In the case of **ROE**, the regression models have lower and more volatile explanatory power, with R² values ranging from 0.035 to 0.320. It is observed that only in 2024 does the model gain greater significance, suggesting a stronger correlation between the explanatory variables and return on equity in the recent period.

Unlike ROA, the Altman Z-score does not have a significant influence on ROE in any year, suggesting that return on equity is not directly determined by bankruptcy risk, but rather by financial structure and financing decisions.

A notable result emerges for the Conan & Holder score in 2024, where the coefficient is positive and significant, and the standardized value indicates a strong impact on ROE. This suggests that, in the recent period, this indicator better captures the relationship between risk and equity performance, possibly due to a better fit with the specific characteristics of the companies analyzed.

Table 6. Determinants of ROE: Linear Regression Results

ROE vs	Indicator	2019	2020	2021	2022	2023	2024
Altman	Estimate	0.000	0.001	-0.041	-0.030	0.002	0.001
Altman	Stand. Estimate	-0.096	0.041	-0.067	-0.286	0.164	0.051
Altman	p	0.720	0.879	0.645	0.121	0.616	0.831
Conan & Holder	Estimate	-0.084	-0.087	6.942	0.003	0.004	1.021
Conan & Holder	Stand. Estimate	-0.113	-0.179	0.008	0.019	0.078	0.563
Conan & Holder	p	0.463	0.241	0.393	0.896	0.575	<.001
Current Ratio	Estimate	0.005	0.005	0.239	-0.018	-0.022	0.039
Current Ratio	Stand. Estimate	0.243	0.167	0.924	-0.564	-0.631	0.413
Current Ratio	p	0.510	0.735	0.538	0.552	0.354	0.604
Quick Ratio	Estimate	-0.001	-0.002	-0.337	0.038	0.031	-0.047
Quick Ratio	Stand. Estimate	-0.030	-0.054	-1.075	0.703	0.833	-0.471
Quick Ratio	p	0.950	0.929	0.473	0.465	0.265	0.550
	R ²	0.035	0.046	0.175	0.066	0.161	0.320
	Adjusted R ²	-0.051	-0.039	0.102	-0.017	0.086	0.260

Source: Author's own calculations using Jamovi software; data processed and organized in Microsoft Excel

With regard to liquidity, neither the Current Ratio nor the Quick Ratio had a significant impact on ROE during the period under review. Although the standardized ratios are high in some cases, the lack of statistical significance indicates that these relationships are not robust.

Overall, the regression analysis confirms the conclusions previously drawn from correlations but adds an important dimension: the relationships between performance and risk are unstable and dependent on the economic context, and the ability of financial indicators to explain performance is limited. Clearly, ROA is better explained by the included variables than ROE, suggesting that operational performance is more sensitive to fundamental factors, while return on equity is influenced by additional elements, such as capital structure or specific financial policies.

Conclusions.

The analysis conducted on companies listed on the regulated market of the Bucharest Stock Exchange for the period 2019–2024 highlights a complex, dynamic, and often unstable relationship between financial performance and indicators of risk, liquidity, and financial structure. Integrating the results obtained from the analysis of distributions, correlations, and linear regressions allows for the formation of a coherent picture of the mechanisms governing company performance in an emerging market.

First, the analysis of indicator distributions shows that most companies operate in a zone of moderate profitability, for both ROA and ROE, with a consistent concentration in the lower ranges. This structure reflects the characteristics of a developing market, where resource efficiency and profit-generating capacity are limited by structural factors. At the same time, bankruptcy risk indicators (Altman and Conan & Holder) suggest relative financial stability at the aggregate level, but with significant differences between companies, indicating high heterogeneity in the sample.

The correlation analysis revealed that ROA is more closely and consistently correlated with risk and liquidity indicators than ROE, suggesting that operational performance is more sensitive to a firm's financial fundamentals. The positive relationships between ROA and the Z-score, as well as liquidity indicators, confirm that firms that are more stable and better managed in terms of working capital tend to use their assets more efficiently. In contrast, ROE exhibits weaker and more volatile correlations, indicating the influence of additional factors, such as capital structure or financing decisions.

The results of the linear regressions reinforce these observations, highlighting a higher explanatory power for the ROA models compared to the ROE models. Although the R² values generally indicate

models of moderate strength, they are sufficient to underscore that the analyzed variables only partially explain financial performance. An important finding is the absence of a stable model over time, with significant relationships appearing sporadically, particularly in 2022, a period characterized by post-pandemic economic adjustments. In this context, both risk indicators (Altman, Conan & Holder) and liquidity indicators had a more pronounced influence on ROA, suggesting increased sensitivity of performance to macroeconomic conditions.

In the case of ROE, the regressions confirm a low dependence on the analyzed indicators, with the exception of isolated cases, such as the significant influence of the Conan & Holder model in 2024. This difference between ROA and ROE indicates that return on equity is influenced to a greater extent by firm-specific internal factors, such as financing policy or capital structure, and less by traditional risk and liquidity indicators.

Another relevant finding relates to liquidity, which, although it shows positive correlations with performance, does not emerge as a robust determinant in the regression models. This discrepancy suggests the existence of indirect or nonlinear relationships, but also the possibility that a high level of liquidity may, in certain cases, reflect an inefficient use of resources. Similarly, financial leverage does not emerge as a significant explanatory factor, indicating a relatively prudent use of debt among the analyzed companies.

Regarding stock returns, both the distribution analysis and the correlations and regressions confirm the absence of a stable relationship with accounting performance. This result highlights the specific nature of the Romanian capital market, where stock prices are influenced not only by financial fundamentals but also by external factors, such as investor sentiment, market liquidity, or the macroeconomic context.

Overall, the study highlights that financial performance among companies listed on the Bucharest Stock Exchange (BVB) is determined by a complex set of factors, and the relationship with risk is neither linear nor constant over time. Among the indicators analyzed, financial stability and, to a certain extent, liquidity play a more significant role in explaining operational performance (ROA), while return on equity (ROE) remains more difficult to model using traditional variables.

These results confirm the specific nature of emerging markets and suggest the need for more advanced approaches that integrate additional factors, such as corporate governance, sectoral structure, or macroeconomic variables. The study thus provides a solid empirical foundation for the development of more complex future models and contributes to a better understanding of the relationship between performance and risk in the context of the Romanian capital market.

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IMPROVING THE MANAGEMENT OF UKRAINE'S IRRIGATION AND DRAINAGE INFRASTRUCTURE WHILE APPLYING ESG REQUIREMENTS

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Abstract: *The main problems of managing irrigation and drainage infrastructure facilities in Ukraine are considered in connection with the practice of applying ESG methods for environmental, social and management components in relation to the provision of irrigation and drainage services. In the context of harmonizing the financial reporting of Ukrainian enterprises with the reporting requirements of the EU countries, a regulatory framework is being prepared for the implementation of sustainable development reporting as part of public reporting of enterprises. According to the requirements of ESG-reporting, information disclosure is provided for the following items: presentation of consequences of the use of natural resources in the format of ESG-reporting, which discloses information about the activities of companies in the field of Environmental aspects, Social responsibility and corporate Governance. Including irrigation and drainage engineering infrastructure in the scope of activities and reporting will contribute to a significant improvement in the condition and return on such assets of water users. The article substantiates the need to provide water users of Ukraine with information on the management of infrastructure facilities in ESG-reporting. The introduction of ESG management elements into the practice of operators and water users will contribute to the restoration of engineering infrastructure facilities and the increase in the area of irrigated land, drainage systems, achieving and maintaining good condition of river basin areas, protecting territories and settlements from the harmful effects of water. The paper highlights the problems of managing irrigation and drainage infrastructure facilities in Ukraine, reflects the practice of applying ESG methods.*

Key words: *ESG, ESG reporting, sustainable development, infrastructure management.*

JEL: Q25, Q56, Q58

Introduction

In Ukraine, due to the low level of natural moisture supply and the poor condition of the irrigation and drainage engineering infrastructure, there is an urgent need for significant restoration of irrigation and drainage engineering infrastructure facilities, which has been confirmed in regulatory legal acts [1, 2]. Previously, the solution of the problems of applying ESG factors was highlighted [3], the importance of developments in ESG reporting [4], ESG indicators in the priority of irrigation and drainage infrastructure in Ukraine [5], and the role of ESG reporting of companies in water resources management was indicated [6]. The works reveal individual aspects of ESG regarding the regulation of the irrigation and drainage sector [9-13]. The rational use of irrigation and drainage infrastructure facilities and water resources by water user companies requires the development of strategies and adherence to their chosen policies in terms of managing these facilities: drawing up programs and plans; implementing environmental protection actions, reflecting the economic effect and documenting all transactions; minimizing negative impacts on the environment. Previously, the use of ESG indicators to stimulate the development of the irrigation and drainage sector was not considered. Despite the current lack of experience in reporting water users in Ukraine according to ESG rules, research and problem-solving of best management practices are needed. **The purpose of the study:** to indicate the directions for improving the management system of the engineering infrastructure of irrigation and drainage of Ukraine through the implementation of ESG-factor components.

Materials and methods Comparison, analysis

Basic content

A modern element of management in the global world is the responsibility of business entities and the publication of reports on their activities according to ESG standards. The growing importance of regulatory influence on the practice of operating enterprises in Ukraine is due, in particular, to the introduction of requirements for mandatory disclosure of information on sustainable development in their reports into regulatory acts on accounting and financial reporting of enterprises. The composition and structure of ESG reporting will be based on the approved taxonomy, consistent with EU practice. ESG performance is measured by integrating quantitative and qualitative indicators. Quantitative indicators are measurements of physical indicators: water supply and withdrawal volumes, use of drainage water for irrigation; rational energy consumption, number of accidents at work; qualitative indicators are policies, procedures and systems implemented by the company: anti-corruption rules, codes of ethics, carbon footprint reduction plans, etc. [7].

Problems of management of irrigation and drainage infrastructure facilities in Ukraine

Based on the recognized facts that with insufficient moisture supply, crop yields directly depend on the ability of irrigation systems to function effectively, it is necessary to provide water for irrigation of crops at the right time and in sufficient quantities. Growing high and stable yields on irrigated and drained lands is possible provided that the engineering infrastructure facilities of land reclamation systems are in proper, operational technical condition. Scientific research has proven that the situation in the irrigation sector in Ukraine is in crisis and the existing engineering infrastructure of irrigation and drainage systems is further deteriorating. In recent years, there has been a significant reduction in the area of actual irrigation; outdated pumping and power equipment in irrigation systems has reached its standard operating life, the water supply process is characterized by high energy intensity and is accompanied by high costs for water supply, which means that water users, agricultural producers, and farmers cannot pay for significantly increased services and irrigate their lands. The scientific and conceptual principles of the restoration and development of irrigation and drainage in Ukraine have become the basis for the justified introduction of an innovative and investment model of management in the field of irrigation and drainage through the implementation of the "Irrigation and Drainage Strategy..." using an integrated approach with the simultaneous implementation of measures to modernize land reclamation systems, institutional reform, and legislative support [1, 8].

Further development of the reform of the field of management of irrigation and drainage infrastructure facilities involves a transition to the process of generating revenues by organizations providing services from the performance of work on the provision of services for the abstraction (delivery) and/or diversion of water for the needs of hydrotechnical land reclamation. The operator, as a person providing services, is obliged to provide services for the abstraction (delivery) and/or discharge of water for the needs of hydrotechnical land reclamation, as well as to meet other needs of water users in water resources not related to hydrotechnical land reclamation, subject to the availability of appropriate technical capabilities and water resources, to all owners (users) of land plots included in the service area of the land reclamation network (another component of the land reclamation system) operated by it, as well as to other water users. The specified management system model provides for increasing the level of reliability and ensuring the effective functioning of engineering infrastructure facilities of land reclamation systems of Ukraine, which are state-owned and provide services to water users, based on the essence of the land reclamation system as a technologically integrated complex that ensures the intake and delivery of water from the water discharge point/its discharge to the water discharge point. When implementing such foundations, measures should be taken to ensure the sustainable functioning of irrigation and drainage systems, in particular through the restoration and modernization of engineering infrastructure facilities and the operation and maintenance of existing systems, and a well-founded selection of priority facilities for

system restoration should be made; necessary work should be carried out to ensure a high operational condition of engineering infrastructure facilities and the operating mode of such facilities; sufficient volumes of water for irrigation are taken into account, the deficit in water supply capacity is eliminated, etc. It is also envisaged to implement investment programs of the operator of engineering infrastructure facilities of land reclamation systems that are in state ownership on the basis of relevant calculations, justification of the feasibility and effectiveness of such measures [2]. Therefore, it is necessary to introduce the latest models of management of land reclamation infrastructure facilities. In Ukraine, there is already positive experience in the functioning of a progressive form of servicing engineering infrastructure facilities - water user organizations (WUs) - a water user organization is a non-profit legal entity created to ensure the use, operation, maintenance, construction and/or restoration of engineering infrastructure facilities of land reclamation systems in order to provide services to customers [2]; currently, 77 WUs have been established in 14 regions of Ukraine, of which 64 organizations are in irrigation, and 13 units are in drainage. Of the total number, 10 WUs have already become owners of land reclamation infrastructure, and 35 units have registered land reclamation infrastructure objects in the State Land Cadastre of Ukraine, thereby acquiring the right to acquire them as property.

The successful implementation of the reform of the management of the engineering infrastructure of land reclamation systems in Ukraine involves the use of effective management elements, among which measures based on ESG approaches occupy a prominent place.

Practice of applying ESG methods

When developing the main principles of the management methodology regarding the environmental component - promoting the sustainable development of entities managing irrigation and drainage infrastructure through the use of methods to stimulate the introduction of the latest technologies for the conservation and rational use of water and land resources in the management of irrigation and drainage systems infrastructure; the introduction of resource-saving technologies and the preservation of the natural **environment**. Significant efforts are being made to use renewable energy sources, reduce the impact of climate change, implement water users' own environmental policies, use natural resources with low impact on nature, recultivate agricultural lands, promote the development of a "circular" economy, and stimulate the expansion of the production of eco-products. In the implementation of this component in Ukraine, educational seminars, trainings and consultations are conducted for farmers on the implementation of environmental practices, technologies that reduce the negative impact on the environment, such as water-saving irrigation systems or organic farming methods [9]; management methods that ensure environmental sustainability are analyzed, namely investments in organic farming, soil restoration, water resource conservation; energy efficiency is ensured by promoting the implementation of technologies and practices that reduce energy consumption [10]. The environmental component of the management system model includes indicators that characterize the impact of the enterprise's activities on the environment: the level of energy efficiency, indicators of the use of water and material resources [11, 13]. It is expected to reduce losses from the deterioration of the impact of climate change, ensure the protection of territories from the harmful effects of water, contribute to the improvement of the ecological state of water (river) basins, carry out the restoration (including those damaged after hostilities) of objects, etc. In Spain, for example, any agricultural investment must take into account ESG criteria, primarily out of conviction, but also due to market and investor demands; an important direction is considered to be the application of irrigation systems and technologies for efficient water use [12].

Social component - encouraging the creation of new jobs, attracting highly qualified specialists and ensuring the active participation of employees in the management of the water management and reclamation complex, reducing the extraordinary humanitarian impact of the war on the population of the area served by the reclamation network, participating in social projects to assist people affected by the war (social housing, social protection and volunteer movement, etc.), data protection and

confidentiality, employment of war veterans; expanding the possibilities of using infrastructure facilities, for example, tourism, recreation, implementation of gender policy, restarting the Ukrainian model of development in the deoccupied territories, etc. Currently, the role of communities in self-government tariff setting is being strengthened. Social aspects include workers' rights, gender equality, training, occupational safety, and supply chains [13].

The management (corporate **Governance** component) is moving towards a model of decentralized management of irrigation and drainage infrastructure with financial support for the functioning of the irrigation and drainage sector from the funds of service users (fully/partially) using budget funds until the transition to a self-financing regime. It is planned to apply modern management elements, in particular, it is believed that inclusive institutional reform should prioritize decentralization, management models and accountability mechanisms to promote more responsive and participatory management of irrigation and drainage. The purpose of the irrigation and drainage infrastructure is to ensure the functioning of structural objects in a single technological complex on a systemic basis. The formation of a supervisory board and other governing bodies provided for by the charter of the operator of engineering infrastructure objects of land reclamation systems that are in state ownership determines the efficiency and timely adoption of effective management decisions. This makes it possible to ensure the renewal and avoidance of infrastructure decay, reasonably ensure the attraction of investments in the restoration of infrastructure facilities, finance land reclamation facilities with a short payback period and postpone the need for significant investments in other facilities. The flexible nature of irrigation and drainage infrastructure management should meet the requirements of new market-oriented models of private commercial management and farming. The management component also includes anti-corruption measures, transparency, corporate ethics and risk management [13]. The development of audit and internal control is envisaged, the widespread introduction of environmental, including water, audits, economic recovery and elimination of losses from destruction, an adequate management system, risk accounting, restructuring of companies, strengthening their business reputation and adjusting the current and long-term strategy, as well as promoting the development of new forms of infrastructure management, in particular, WUs.

Conclusions

Improving the management of irrigation and drainage infrastructure using ESG indicators requires simultaneously considering the prospects for activating two factors: providing financial resources for the maintenance and renewal of infrastructure facilities and increasing the impact of environmental and social factors on business processes in the development of irrigation and drainage in Ukraine, on the one hand, and the prospect of influencing the assessment and strengthening the competitive positions of business entities based on ESG indicators in the markets, on the other. The irrigation and drainage infrastructure management model based on the use of ESG metrics and characteristics will allow business entities to effectively manage transformational programs that stimulate positive changes in the business, attract investments in the implementation of innovative projects, and strengthen their status as a competitive partner in the market.

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DEONTOLOGICAL PRINCIPLES IN ACCOUNTING EXPERT ENGAGEMENTS: CHALLENGES, RISKS AND RESPONSIBILITIES

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Abstract: *In the performance of a professional and legal accounting audit, adherence to ethical principles is an essential element. The importance of this topic stems from the complexity of the challenges specific to accounting audits and the auditor's responsibility in the practice of the profession. In the face of these challenges, the ethics of accounting auditing become the key link that distinguishes professionalism from superficiality. This study emphasizes the importance of strengthening professional responsibility and adhering to ethical standards in practice. The article aims to highlight the fundamental principles governing the work of the accounting expert, while also identifying directions for improving the national regulatory framework in this field. During the research, a qualitative analysis of doctrinal, regulatory, and professional sources related to the topic was conducted, including the comparative method. This scientific research involved a critical examination of the discrepancies between current regulations and the practical needs of the profession, outlining the main ethical challenges faced by certified public accountants in the practice of their profession. The research aims to synthesize the main ethical principles applicable to the practice of public accounting in a structured and accessible format that facilitates the understanding and application of ethical standards by public accountants. At the same time, the article highlights the need to adopt best practices applicable to the accounting profession, inspired in part by the provisions of Professional Standard No. 35 in Romania, with a view to improving the domestic professional framework.*

Key words: *accounting expertise, deontological principles, professional ethics, accounting expert*

JEL: M41, M42, O33

Introduction

The current socio-economic context of the Republic of Moldova is characterized by significant transformations generated by the need to harmonize national legislation with the standards of the European Union. These developments lead to multiple legislative changes and require entities to continuously adapt their systems for organizing economic and financial activities. Another characteristic of the current context is the accelerated use of digital resources and the expansion of artificial intelligence applications in economic and financial activities. Thus, the processes of digitalization and legislative harmonization significantly modify the traditional forms of carrying out economic and financial activities, generating implications also for the manner in which accounting expertise is conducted and for the professional responsibilities of the accounting expert.

The present research aims to identify the key deontological principles applicable to the activity of the accounting expert, based on the legislation in force and international best practices. This study seeks to provide a better understanding of the mission of the accounting expert by highlighting the challenges faced in professional activity. At the same time, the main purpose of the research is to provide theoretical and practical support to accounting experts in the exercise of their profession and to strengthen confidence in accounting expertise activities.

It should be noted that, in the Republic of Moldova, there is literally no distinct specialization of accounting expert regulated at the legislative level, the activity of the accounting expert being largely integrated into the field of judicial expertise. Thus, aspects related to the deontological conduct and professional responsibility of the accounting expert are not reflected in specific normative acts, but

require the cumulative application of several normative sources, such as the Handbook of the Code of Ethics for Professional Accountants and the Code of Deontology of the Judicial Expert.

Basic content.

According to the Explanatory Dictionary, deontology represents the totality of norms and principles regulating the conduct of a professional in the exercise of their activity. It should be emphasized that, although the notions of ethics and deontology are similar in meaning, they refer to different aspects: ethics refers to the moral norms and principles that characterize human behavior, whereas deontology refers to the conduct and obligations specific to a profession. In the field of accounting expertise, compliance with deontological principles is of major importance, since the activity of the accounting expert involves formulating objective and professional conclusions that may influence decision-making processes and the resolution of disputes. For this reason, the accounting expert must carry out their activity with impartiality, independence, and professionalism.

The analysis of specialized literature and relevant normative acts highlights the fact that, in the Republic of Moldova, there is no distinct national code of ethics for professional accountants, the applicable framework being the International Code of Ethics for Professional Accountants, approved at the national level by the Ministry of Finance.

The International Code of Ethics for Professional Accountants issued by the International Ethics Standards Board for Accountants (IESBA) [3] establishes the fundamental principles governing the activity of accountants, including that of the accounting expert.

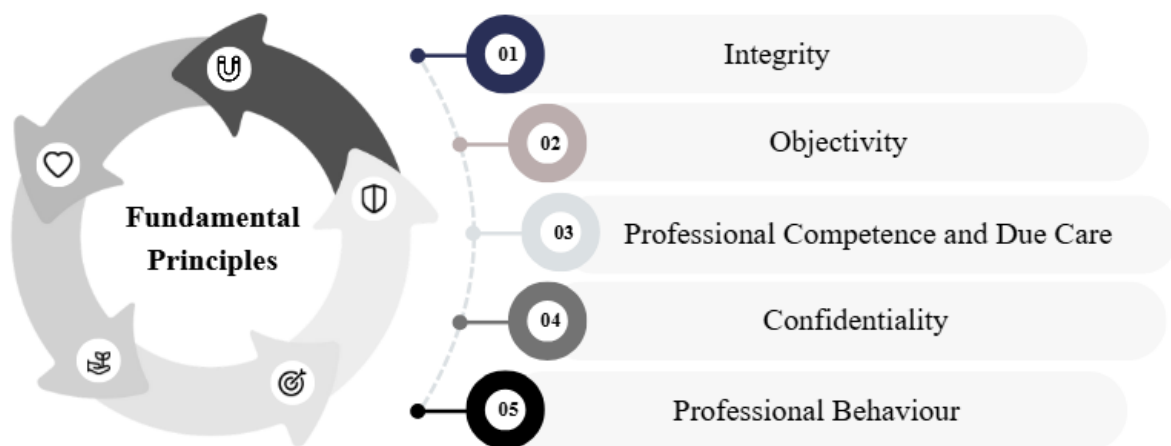


Figure 1. Fundamental principles underlying the activity of the accounting expert according to the International Code of Ethics for Professional Accountants

Source: Prepared by the author based on [3]

The characteristics of each principle highlight the ethical framework that governs and requires accounting experts to apply these principles throughout the exercise of their profession.

- Integrity – according to the author Coșleț A., integrity implies fairness, honesty, and the professional's ability to act in accordance with ethical principles, even in situations where external pressures could lead to conduct contrary to those principles [2].
- Objectivity – represents the obligation of the accounting expert to avoid prejudice, conflicts of interest, or undue external influences that could affect professional judgment or the decisions adopted in the exercise of professional activity.
- Professional competence and due care – the accounting expert must continuously update their professional knowledge and skills in order to ensure competent services compliant with the latest legislative, digital, and deontological developments.

- Confidentiality – within professional relationships, the accounting expert must preserve the commercial confidentiality of financial statements and ensure the non-disclosure of such information, except where a legal obligation arises.
- Comportamentul Professional behavior – in addition to the above-mentioned principles, the accounting professional has the obligation to strictly comply with the legislation and to refrain from actions or omissions that could prejudice the expert report, as well as the reputation of the profession as a whole.

In addition to the principles provided by the International Code of Ethics for Professional Accountants, it is important to mention that the activity of the accounting expert is also inherently characterized by the application of the principles established by the Code of Deontology of the Judicial Expert. Given that, in the Republic of Moldova, there is no distinct normative act comprehensively regulating the field of accounting expertise, professionals in this field are required to apply cumulatively the principles and rules provided both by the Code of Ethics for Professional Accountants and by the Code of Deontology of the Judicial Expert, in order to ensure compliance with professional conduct and the deontology of the profession.

The Code of Deontology of the Judicial Expert, which, as previously mentioned, may be considered, in the author's opinion, one of the main benchmarks of the professional conduct of the accounting expert, both in judicial and extrajudicial expertise, establishes a series of fundamental principles that must be observed in the exercise of the profession: legality, moral integrity, objectivity and impartiality, confidentiality, and professionalism [6].

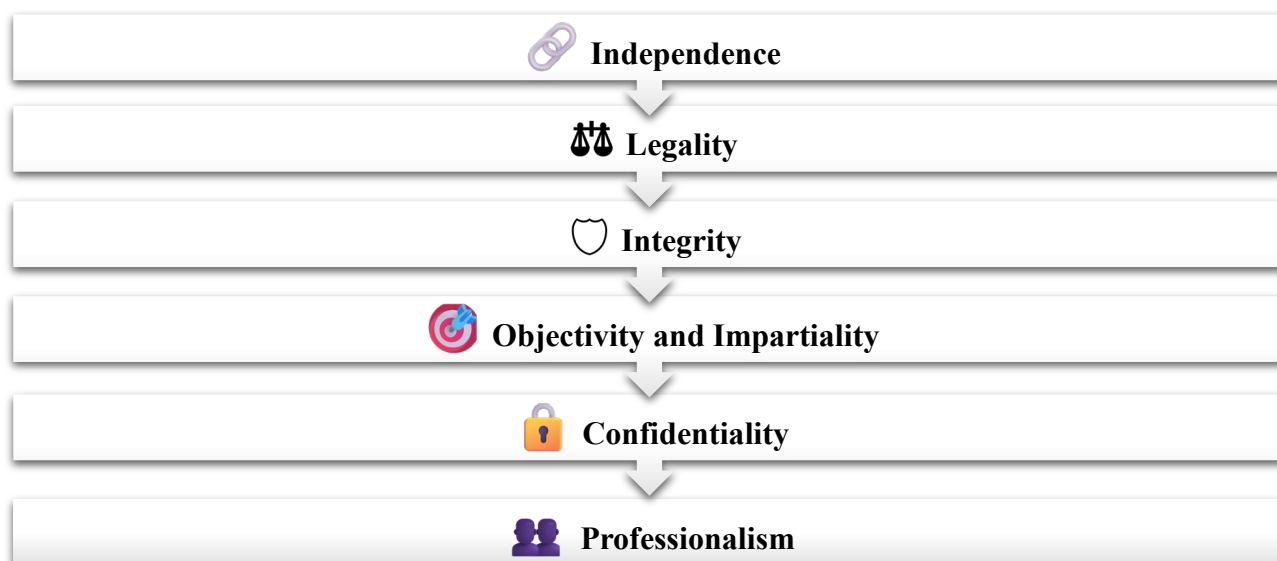


Figure 2. Fundamental principles of the accounting expert's activity, synthesized based on the Code of Deontology of the Judicial Expert

Source: Prepared by the author based on [6]

By comparatively analyzing the principles provided by the International Code of Ethics for Professional Accountants and those established by the Code of Deontology of the Judicial Expert, the existence of common elements may be observed, such as integrity, objectivity, confidentiality, and professionalism. At the same time, the Code of Deontology of the Judicial Expert places greater emphasis on the principles of legality and impartiality, which are specific to judicial activity.

The principle of independence. In order to carry out accounting expertise, the expert must first and foremost comply with the principle of independence. Article 7 of the Law on Judicial Expertise and the Status of the Judicial Expert establishes that, in any situation, the expert, including the accounting

expert, must remain independent from the beneficiaries of the expertise and from the parties interested in the expertise [5]. At the same time, the principle of independence is extensively regulated by the International Code of Ethics for Professional Accountants issued by the IESBA, which highlights the existence of threats likely to affect the independence of the professional accountant. These include self-interest, self-review, familiarity, excessive advocacy of the client's interests, and intimidation. The Code of Ethics emphasizes that the independence of the accounting expert is closely related to the principles of objectivity and integrity. According to the Code, the independence of the professional accountant is characterized by independence of mind and perceived independence.

Independence of mind refers to the specialist's ability to formulate professional conclusions and judgments without external influences. At the same time, perceived independence implies the prudence of the professional accountant and the avoidance of situations that could lead third parties to consider that the impartiality, integrity, or objectivity of the information provided has been compromised [3].

The author emphasizes that, in the context of the accelerated use of technologies based on artificial intelligence, there is a risk of affecting the principle of independence of the accounting expert, particularly independence of mind, through the reduction of the exercise of personal professional judgment.

Even though the provisions of the Code of Ethics are not expressly dedicated to the accounting expert, they are directly relevant to accounting expertise activities, especially in the context of the absence of a distinct regulatory framework in the Republic of Moldova intended exclusively for this profession.

The principle of objectivity and impartiality

The authors Sevciuc T. and Bulgaru V. emphasize that the professional accountant must perform their duties impartially, avoiding the influence of prejudice, conflicts of interest, or other external influences likely to affect the objectivity of the professional judgment exercised [7].

By analyzing the provisions of Subsection 112 "Objectivity" of the International Code of Ethics for Professional Accountants, it may be observed that objectivity implies the obligation of the professional accountant not to compromise professional or business judgment as a result of subjectivity, conflicts of interest, or undue influences exercised by individuals, organizations, technology, or other factors [3]. From the perspective of the Code of Deontology of the Judicial Expert, the principle of objectivity and impartiality literally implies conducting examinations based on an objective and comprehensive assessment of the circumstances under examination, through the application of research methods and techniques appropriate to the investigation. At the same time, the judicial expert must avoid preconceived ideas and maintain an impartial attitude toward any personal, economic, political, religious, or other interests likely to affect the impartiality of the expert report [6].

The principle of impartiality and objectivity of the accounting expert is also relevant for analysis through the provisions of Article 10 of the Law on Judicial Expertise and the Status of the Judicial Expert, which obliges the expert to act in an impartial, fair, and non-discriminatory manner, without allowing their objectivity to be affected by conflicts of interest or influences of a political, racial, ethnic, social, or other nature that could influence the results of the judicial expertise performed [5]. In the author's opinion, compliance with the principle of objectivity is of major importance in accounting expertise activities, since the conclusions formulated may be used as evidence in the resolution of disputes and in the assessment of certain economic and financial circumstances.

The principle of confidentiality

The principle of confidentiality implies the obligation of the accounting expert to protect the information obtained in the exercise of professional activity and to avoid its disclosure without the existence of a justified legal or professional basis. Researcher Munteanu I. emphasizes that the principle of confidentiality "constitutes an essential characteristic of an independently exercised,

organized, and responsible profession, granting the accounting expert a status comparable to that of lawyers, doctors, or notaries" [4, p. 35]. This principle concerns not only the preservation of the confidentiality of information, but also establishes certain limits of professional conduct, relating both to the non-disclosure of information and to the formulation of responses within expert assignments strictly within the limits of the subject matter of the expertise, the accounting expert being obliged to exercise prudence in presenting information unrelated to the subject under examination.

In carrying out accounting expertise ordered in civil or criminal cases, the accounting expert has the obligation to respect the confidential nature of the information obtained in the exercise of professional duties. In this regard, both Article 88 of the Criminal Procedure Code and Article 154 of the Civil Procedure Code establish the obligation of the expert not to disclose circumstances and data that became known as a result of carrying out the expertise or participating in closed court hearings [5,6]. These provisions highlight the obligation of the accounting expert to protect information relating to private and family life, state secrets, commercial secrets, professional secrets, and other categories of information protected by law, thereby reinforcing the importance of the principle of confidentiality in accounting expertise activities.

The Code of Deontology of the Judicial Expert extensively develops the principle of confidentiality, establishing the expert's obligation to protect information obtained in the exercise of professional duties and to avoid disclosing circumstances or data that became known during the performance of the expertise. At the same time, the deontological rules emphasize the obligation of the expert to respect the inviolability of private life, commercial secrecy, professional secrecy, and other categories of information protected by law.

It should also be noted that the obligation of confidentiality extends even to the use of materials related to the expertise for scientific purposes, the Code of Deontology permitting their use only after the final resolution of the case and with observance of anonymity, in accordance with the law [6].

It should be mentioned that the Handbook of the Code of Ethics for Professional Accountants stipulates that "a professional accountant shall continue to comply with the principle of confidentiality even after the relationship between the accountant and a client or employing organization has ended. When changing employment or acquiring a new client, the professional accountant is entitled to use prior experience, but shall not use or disclose any confidential information acquired or received as a result of a professional or business relationship" [3].

In the author's opinion, these provisions emphasize that the principle of confidentiality goes beyond the simple obligation not to disclose information, representing a complex mechanism aimed at protecting the rights of the parties involved in the process and maintaining trust in the activity of the accounting expert.

The principle of professionalism

It should be emphasized that, in order to carry out accounting expertise assignments, the accounting expert must possess the professional competencies necessary for the field of activity. The accounting expert must withdraw from performing any activities for which they do not possess the required competencies.

However, the manner in which these competencies are developed and strengthened raises certain difficulties in the context of the Republic of Moldova, where accounting expertise activity is regulated predominantly through the perspective of judicial expertise. Although the notion of extrajudicial accounting expertise is rarely expressly encountered in national practice and regulations, it cannot be considered nonexistent, since in practice multiple activities involving economic and financial analysis, verification, and interpretation specific to accounting expertise are carried out.

In the Republic of Moldova, accounting expertise activity is regulated predominantly through the perspective of judicial expertise, there being no distinct mechanism for granting the status of accounting expert similar to that existing in Romania through Professional Standard No. 35 [1].

At the same time, specific national regulations exist regarding the activity of judicial experts, including the Nomenclature of Judicial Expertises and the Regulation on the Conditions for Conducting and Passing the Qualification Examination for Granting the Status of Judicial Expert, which allow the obtaining of qualifications as judicial experts specialized in the field of accounting. Researcher Timofti G. emphasizes that "professional training in the field of forensic accounting is generally carried out in universities, as well as through courses offered by international professional certification associations such as ACCA (Association of Chartered Certified Accountants), CFA (Chartered Financial Analyst), ICFA (Institute of Certified Forensic Accountants), and AICPA (Association of International Certified Professional Accountants)" [10].

At the same time, Timofti G. highlights the necessity of developing professional training mechanisms in the field of accounting expertise, mentioning the opportunity to initiate continuing education programs for university graduates, as well as the need to develop interdisciplinary programs in the field of accounting expertise focused on the investigation of economic and financial fraud and adapted to the process of harmonizing legislation with EU requirements [10].

The principle of integrity

By analyzing the provisions of the International Code of Ethics for Professional Accountants, it may be observed that the principle of integrity goes beyond the simple obligation of formal honesty, requiring the manifestation of correct and responsible professional conduct even in situations where the professional accountant is subject to external pressures or influences, the same approach also being reflected in the Code of Deontology of the Judicial Expert.

In the author's opinion, compliance with the principle of integrity by the accounting expert may be unintentionally and disinterestedly compromised by the very accounting information on which the expert report is based, since such information may already exceed the limits of integrity before reaching the expert. Therefore, the activity of the accounting expert requires the manifestation of a high level of professional skepticism, as the accounting information and documents examined during the expertise may be incomplete, distorted, or previously manipulated before the expertise is conducted. For this reason, the accounting expert must critically analyze the information examined and apply appropriate procedures to verify its credibility.

The principle of legality

According to the Code of Deontology of the Judicial Expert, in the exercise of their activity, the judicial expert is obliged to comply with the Constitution of the Republic of Moldova, the legislation in force governing the field of judicial expertise, as well as the international treaties to which the Republic of Moldova is a party. Thus, the principle of legality implies the performance of accounting expertise activities strictly within the limits of the applicable regulatory framework, the accounting expert being obliged to carry out their activity in compliance with procedural, professional, and deontological rules, including within extrajudicial accounting expertise assignments.

The importance of legality is also emphasized by researcher Sgârdea F. in the paper Financial Control and Accounting Expertise, where the author stresses that "in all cases where accounting experts requested to perform judicial and extrajudicial accounting expertise are in a situation of incompatibility, they have the deontological obligation to refrain from carrying out such assignments." At the same time, the author mentions that, where the accounting expert fails to submit a declaration of withdrawal, they may be subject to the recusal procedure provided by law [8].

Compliance with the principle of legality in the activity of the accounting expert is also ensured through procedural rules regulating incompatibilities and the institution of recusal of the judicial expert established by the Civil Procedure Code (Art. 51), the Criminal Procedure Code (Art. 89), and other special regulations.

Therefore, the accounting expert, regardless of whether they perform a judicial or extrajudicial assignment, must base their activity on the deontological principles analyzed above, as well as on objective and well-founded professional data and reasoning. Otherwise, subjective conclusions or

conclusions insufficiently substantiated by the materials of the case may be considered inadmissible, lacking credibility, and may entail the legal liability of the accounting expert.

Responsibility and compliance with deontological principles in the preparation of accounting expertise reports represent a fundamental pillar of the profession, contributing to maintaining the credibility of accounting expertise activities. At the same time, the author considers that, in addition to compliance with deontological principles, it is necessary to clearly and systematically regulate the rights, obligations, and prohibitions applicable to the accounting expert. În vederea analizei statutului profesional și deontologic al expertului contabil judiciar, în Tabelul 1 sunt sintetizate principalele drepturi, obligații și interdicții aplicabile acestuia.

Table 1. Rights, obligations, and prohibitions of the accounting expert

Rights	Obligations	Prohibitions
- To examine the case materials; - To participate in establishing the objectives of the accounting expertise and, where necessary, to request the modification or supplementation of those objectives; - To obtain clarifications and explanations from the parties involved in the expertise assignment, where appropriate, with the authorization of the competent authorities (the judge or the authority ordering the expertise); - To request additional materials necessary for formulating conclusions; - To request the performance of a control/audit where it is determined that the accounting expertise cannot be carried out without it; - To request reimbursement of expenses related to the performance of the expertise; - To receive remuneration for the work performed.	- Formulating objective and well-reasoned conclusions; - Refusing to perform the expertise in the absence of the necessary competence or sufficient materials, or in the presence of circumstances of incompatibility; - Providing explanations regarding the expert report; - Confirming qualifications and objectively assessing one's own competence; - Declaring relationships with the participants in the proceedings; - Complying with procedural rules and maintaining proper conduct during court hearings; - Communicating the results only to the authority ordering the expertise; - Respecting the confidentiality of information; - Resisting external influences on the expertise; - Informing the competent authorities about attempts to improperly influence the expertise.	- To breach deontological principles, ethical rules, and the principle of good faith in the exercise of professional activity; - To entrust the performance of the expertise to a third party; - To disclose information that became known in the course of the assignment; - To collect from the parties any documents unrelated to the case and attach them to the expert report; - To perform financial management control, inventory-taking, or the updating of accounting records related to the expertise performed; - To distribute the expert report to third parties without the consent of the competent authority and prior to the final resolution of the case.

Source: Prepared by the author based on [5,6,3,9]

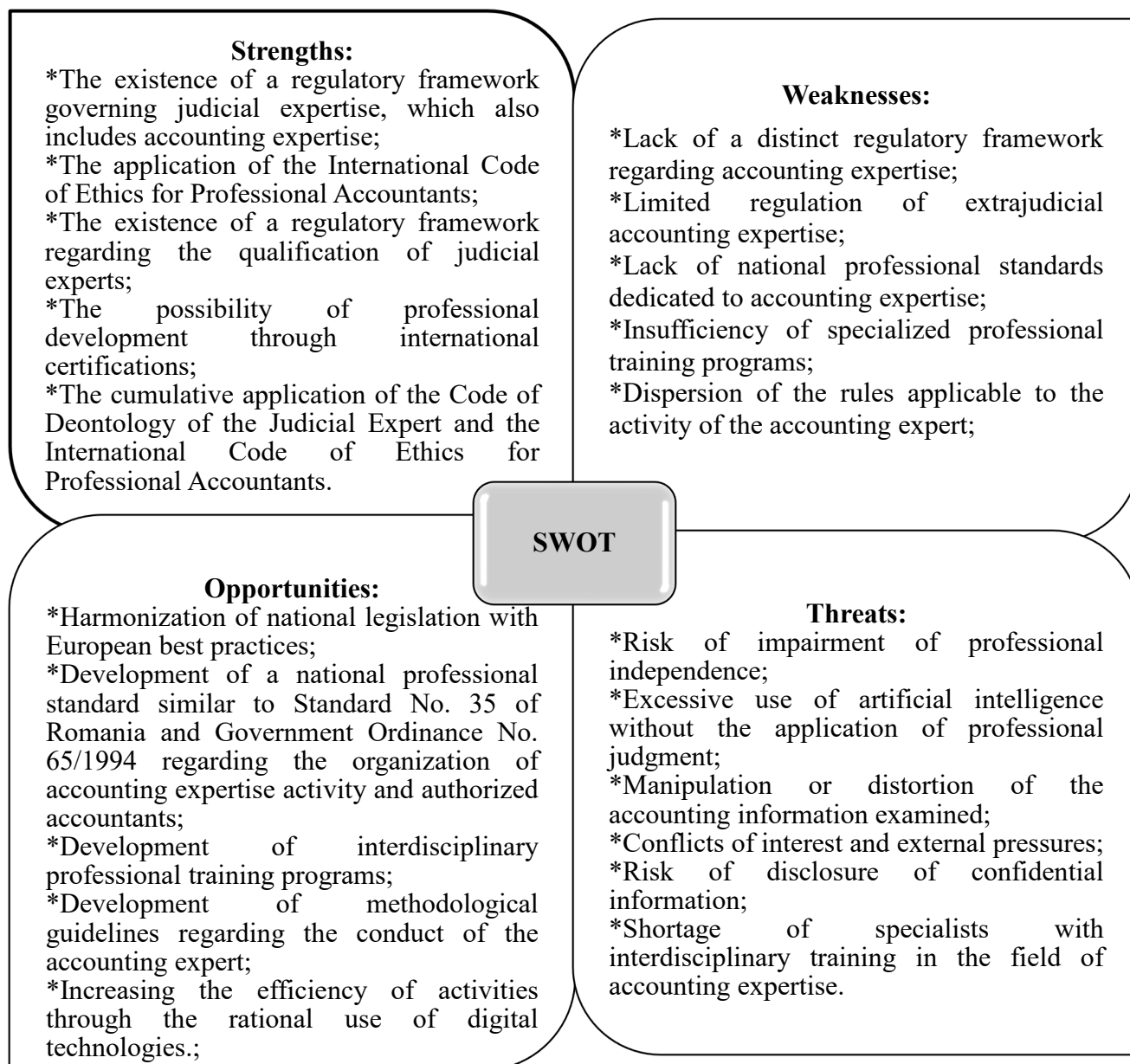
The analysis of the rights, obligations, and prohibitions applicable to the accounting expert demonstrates that accounting expertise activity requires not only technical competencies, but also strict compliance with deontological, professional, and procedural rules.

Conclusions

In conclusion, accounting expertise activity involves compliance with a complex set of deontological, professional, and legal principles intended to ensure the objectivity, credibility, and quality of the conclusions formulated by the accounting expert. The conducted research highlights the fact that, in

the Republic of Moldova, accounting expertise activity is regulated predominantly through the perspective of judicial expertise, thus revealing the need to strengthen the regulatory and professional framework applicable to this field.

In order to synthesize the main aspects identified throughout the research, as well as to highlight the challenges and development perspectives of accounting expertise activity in the Republic of Moldova,



the author considers it relevant to conduct a SWOT analysis of the analyzed field.

Figure 3. SWOT Analysis of the Activity of the Accounting Expert in the Republic of Moldova

Source: Prepared by the author

Therefore, the author emphasizes the need to pay increased attention to the field of accounting expertise in the Republic of Moldova, since the activity of the accounting expert represents an essential element of the economic and financial system and of the administration of justice. At the same time, the research highlights the existence of normative and professional gaps that may generate

difficulties in the proper exercise of accounting expertise activities, thus requiring the strengthening of regulatory mechanisms, professional training, and the application of deontological principles.

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HUMAN CAPITAL DEVELOPMENT IN ROMANIA: AN ECONOMIC ANALYSIS OF TERTIARY EDUCATION REFORM AND LABOUR MARKET OUTCOMES

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Abstract: *The reform of higher education in Romania represents a critical dimension of economic development, particularly in the context of aligning human capital with evolving labour market demands. This study examines the relationship between higher education outcomes and employment performance, highlighting structural imbalances in the Romanian education system. Using data from Eurostat (2025) and the OECD (2025), the analysis reveals a declining trend in tertiary educational attainment among individuals aged 25–34, from 24.7% in 2022 to 23.0% in 2025, placing Romania significantly below the European Union average. At the same time, the employment premium for tertiary graduates remains above the OECD average, indicating strong labour market demand for highly educated individuals and suggesting a shortage of qualified workforce. This paradox reflects a persistent mismatch between the supply of graduates and the needs of the economy. The paper further explores key policy directions for reform, including performance-based funding, university–industry partnerships for research and innovation, internationalisation strategies, and the development of applied and industrial scholarship schemes. Drawing on OECD recommendations, the study emphasises the need for systemic coherence between education policies and labour market requirements. The findings suggest that improving tertiary education outcomes is essential not only for increasing employment rates but also for enhancing productivity and long-term economic competitiveness. The paper concludes that sustainable reform requires an integrated approach that links funding mechanisms, institutional performance, and labour market integration in order to better align educational outcomes with industry needs.*

Key words: *human capital, tertiary education, higher education reform, labour market, educational policies, Romania*

JEL: I23, J24, I25, J21

Introduction

The economic and technological transformations of recent decades have led to an increase in the importance of human capital in supporting economic competitiveness and sustainable development. In the context of the ‘ ’ knowledge-based economy, education and skills development are essential factors for increasing productivity, stimulating innovation and adapting the labour market to the new demands generated by digitalisation and globalisation (Zhang et al., 2026). Thus, higher education

plays a strategic role in training highly skilled human resources and in supporting long-term economic performance.

The literature highlights that investment in education generates significant benefits both at the individual level, by increasing employment opportunities and incomes, and at the macroeconomic level, by strengthening competitiveness and innovation capacity (Belfield & Bailey, 2019). At the same time, structural changes in the labour market require the development of complex and flexible skills, focused not only on the accumulation of theoretical knowledge, but also on the ability to adapt, collaborate and integrate into dynamic economic contexts (Deming & Silliman, 2025).

In the European context, the relationship between higher education and the labour market is influenced by internationalisation processes and the emergence of global labour markets for higher education graduates (Lauder & Mayhew, 2020). In these circumstances, universities must simultaneously meet the needs of the national economy and the demands of international competition for advanced skills and high-performing research.

In Romania, higher education reform is becoming a strategic priority in the context of persistent mismatches between the skills provided by universities and those demanded by the labour market. Although higher education graduates enjoy significant advantages in terms of employment, Romania continues to have one of the lowest proportions of young people with tertiary education in the European Union (Eurostat, 2025). This situation highlights the need to develop educational policies focused on employability, innovation, research and international collaboration (Petrescu, 2025).

The aim of this paper is to analyse the relationship between human capital development, higher education performance and labour market outcomes in Romania, in the context of the reforms needed to align university education with the demands of the contemporary economy. Building on this aim, the research seeks to answer the following research question: To what extent can higher education reform help reduce the mismatch between the skills provided by universities and the demands of the labour market in Romania?

Theoretical Background

The concept of human capital is one of the essential theoretical foundations of the economics of education and modern economic development. The first conceptual approaches were formulated by Schultz and Becker, who highlighted the role of investment in education, vocational training and health in enhancing individuals' skills, productivity and labour capacity. From this perspective, education is interpreted not only as a social process, but also as a strategic economic investment, capable of generating returns both at the individual level, through increased income and employment opportunities, and at the macroeconomic level, through enhanced competitiveness and sustainable development (Zhang et al., 2026). In recent economic literature, human capital theory is being reconsidered in light of labour market transformations and the new demands generated by digitalisation and automation. Deming and Silliman (2025) emphasise that traditional approaches treat human capital in a one-dimensional manner, with it being assessed predominantly through educational attainment or academic results. The authors argue, however, that the contemporary labour market requires a more complex perspective on skills, in which workers are not perceived exclusively as factors of production, but as agents capable of deciding how to use their skills and allocate professional activities. Thus, in addition to traditional cognitive skills, higher-level skills such as adaptability, collaboration, teamwork and decision-making in dynamic economic contexts are becoming essential (Deming & Silliman, 2025).

The economic importance of higher education is also supported by research on the return on educational investment in the labour market. Studies highlight that investment in university education generates significant benefits in terms of employment, income levels and job stability. Furthermore, these benefits are considered sustainable in the medium and long term, given that knowledge-based economies continue to demonstrate high demand for a highly skilled workforce (Belfield & Bailey, 2019).

The process of economic globalisation has also contributed to transforming the relationship between education and the labour market, fostering the emergence of global labour markets for higher education graduates. In this context, universities are required to respond not only to the demands of national economies, but also to international competition for talent and advanced skills. Professional mobility and the internationalisation of higher education have become essential elements for strengthening economic competitiveness and for integrating graduates into high value-added economic sectors (Lauder & Mayhew, 2020).

The relationship between higher education and the labour market is directly influenced by the ability of educational institutions to generate skills relevant to the economy. Education has both a social and formative role, as well as an economic function geared towards the development of skills and the professional integration of graduates. In the context of the transition to market-oriented economies, skills have become a central determinant of economic performance. However, the literature highlights the existence of mismatches between the skills provided by higher education institutions and those demanded by employers. These mismatches are caused by imperfections in both the education market and the labour market, and are exacerbated by information asymmetries and the difficulty of rapidly adapting education systems to economic and technological changes (Assaad et al., 2018).

In this context, structural reform of higher education becomes an essential tool for modernising educational systems and increasing the economic relevance of universities. Structural reforms are defined as interventions initiated or supported by governments, aimed at altering the architecture and functioning of the higher education system, including the roles and positions of higher education institutions within the education system. These reforms aim to transform the university landscape by strengthening institutional performance, research and links with the business sector (de Boer et al., 2017).

In Romania's case, the need for higher education reform is driven both by the structural challenges of the labour market and by the objectives of economic competitiveness and regional development. In this regard, Petrescu (2025) highlights that the Romanian higher education system must evolve towards a model focused on employability, research excellence and international collaboration, capable of supporting Romania's economic transformation and integration into the knowledge-based economy. Better alignment between universities, the labour market and the international research environment is an essential condition for the development of human capital and for strengthening Romania's economic competitiveness (Petrescu, 2025).

To ensure coherence between the theoretical framework and the proposed reform directions for higher education in Romania, it is necessary to highlight the relationship between human capital development and the capacity of higher education institutions to meet the demands of the labour market. The literature emphasises that investment in education and skills development are key determinants of productivity, economic competitiveness and innovation (Zhang et al., 2026). At the same time, the transformations brought about by globalisation, digitalisation and the knowledge-based economy require higher education systems to adapt to new economic and social demands by developing relevant and flexible skills (Deming & Silliman, 2025; Lauder & Mayhew, 2020). In this context, the strategic directions presented in Figure 1 reflect the need for a structural reform of higher education in Romania, aimed at increasing graduate employability, strengthening research and stimulating cooperation between universities and the business sector. Priority actions such as outcomes-based funding, partnerships for innovation and research, internationalisation and the development of industry scholarships aim to reduce the mismatch between the skills provided by universities and those demanded by the labour market, thereby contributing to the development of human capital and the enhancement of Romania's economic competitiveness (Assaad et al., 2018; Petrescu, 2025).

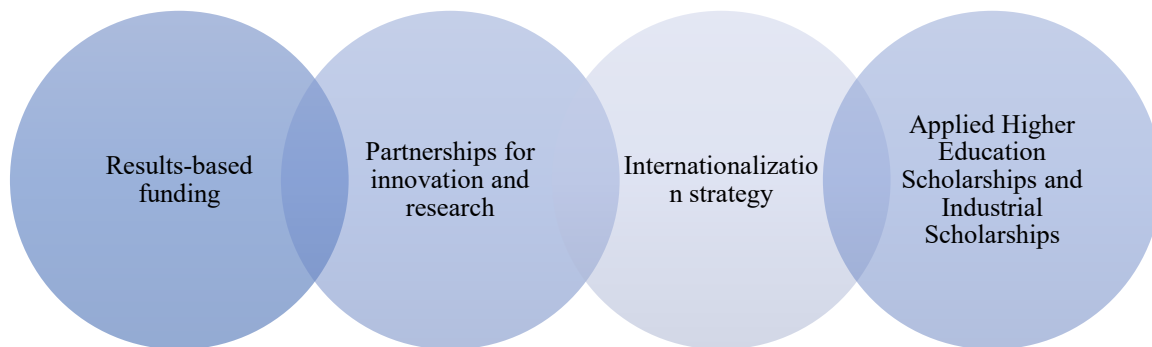


Figure 1. Priority actions in the reform of higher education in Romania

Source: Own elaboration using data from Petrescu (2025)

Figure 1 illustrates the priority actions that can be undertaken in the reform of higher education in Romania. Results-based funding refers to shifting the funding models for public universities towards employability indicators, graduate tracking and the active involvement of the private sector. As regards partnerships for innovation and research, these aim to encourage universities to establish joint research centres, technology incubators and exchange programmes or Erasmus+ schemes with institutions in Asia and the European Union, respectively, as well as with multinational companies. The internationalisation strategy involves streamlining visa, accommodation and accreditation recognition policies to attract international students, academic talent and visiting researchers to universities in Romania. Applied higher education scholarships and industrial scholarships aim to promote research focused on industrial innovation and regional economic development, including master's and doctoral placements within companies and local authorities.

Research methodology

This study employs a descriptive and analytical methodology, with the aim of assessing the relationship between human capital development, higher education performance and labour market outcomes in Romania. The analysis is based on the interpretation of statistical indicators regarding the level of tertiary education and the professional integration of graduates, in the context of the structural reforms necessary to adapt the university system to the requirements of the knowledge-based economy. The main data sources used in the study are the Eurostat database (2025) and the OECD report (2025). The key indicator analysed is 'Persons aged 25–34 with tertiary educational attainment', used to assess the evolution of the proportion of young people with higher education in Romania during the period 2020–2025. The research also includes an analysis of indicators relating to the employability of graduates and the employment advantages for those with tertiary education compared to those with lower educational levels. The research methodology is based on comparative analysis and the socio-economic interpretation of statistical data, aiming to identify the main trends and existing imbalances between the higher education system and the labour market. At the same time, the recommendations formulated by the OECD regarding higher education reform are analysed, with an emphasis on measures aimed at improving institutional performance, internationalisation, outcomes-based funding and the strengthening of partnerships between universities and the business sector.

Results and discussion

The aim of this paper is to analyse the relationship between human capital development, higher education performance and labour market outcomes in Romania, in the context of the reforms needed to align university education with the requirements of the contemporary economy.

The data presented in Table 1 highlight the fluctuating trend in the proportion of people aged between 25 and 34 who have completed tertiary education in Romania during the period 2020–2025. It can be

seen that the indicator stood at 24.9% in 2020, followed by a decline to 23.3% in 2021 and a temporary rise to 24.7% in 2022. From 2023 onwards, the indicator returns to a downward trend, reaching 22.5% in 2023, 23.2% in 2024 and 23.0% in 2025. This trend indicates the persistence of structural vulnerabilities in Romania's higher education system and the continued low proportion of young people with higher education qualifications compared to the European Union average. The downward trend may reflect the cumulative effects of demographic decline, out-migration of young people, university dropout rates and limited access to higher education programmes. From an economic perspective, the reduction in the proportion of tertiary education graduates may contribute to exacerbating the shortage of highly skilled labour and to diminishing the Romanian economy's capacity to support processes of innovation, digitalisation and international competitiveness.

Table 1. Persons aged 25–34 with tertiary educational attainment in Romania

Indicator	2020	2021	2022	2023	2024	2025
People aged 25–34 with tertiary education	24.9	23.3	24.7	22.5	23.2	23.0

Source: Own elaboration using data from Eurostat (2025)

In Romania, completing tertiary education brings significant benefits in terms of labour market integration and career prospects for young adults. OECD data highlight that the employment rate among people with higher education reaches approximately 91%, which is almost double the rate recorded for people with an educational level below upper secondary education, which stands at approximately 48% (OECD, 2024). These differences reflect the high demand in the labour market for highly skilled workers and the importance of advanced skills in the context of the knowledge-based economy. At the same time, tertiary graduates in Romania enjoy more favourable employment prospects than the average recorded across OECD and OECD-EU member states, indicating a competitive advantage associated with university education (OECD, 2025). This highlights the fact that, although Romania has a low proportion of the population with higher education, the labour market demonstrates a significant need for specialists and advanced skills, emphasising the need to reform and modernise the higher education system.

Based on the results obtained and the recommendations made by the OECD (2025), Figure 2 highlights the main strategic directions required to strengthen the performance and economic relevance of higher education in Romania. In this regard, Figure 2 summarises the main recommendations made by the OECD for the reform of tertiary education in Romania, structured around three key dimensions: equity, quality and governance. With regard to the equity dimension, the recommendations focus on prioritising a clear and coherent system of financial support for students, as well as simplifying and expanding pathways to higher education. These measures aim to reduce educational inequalities and increase participation in university studies, particularly among vulnerable groups and the population in underdeveloped areas.

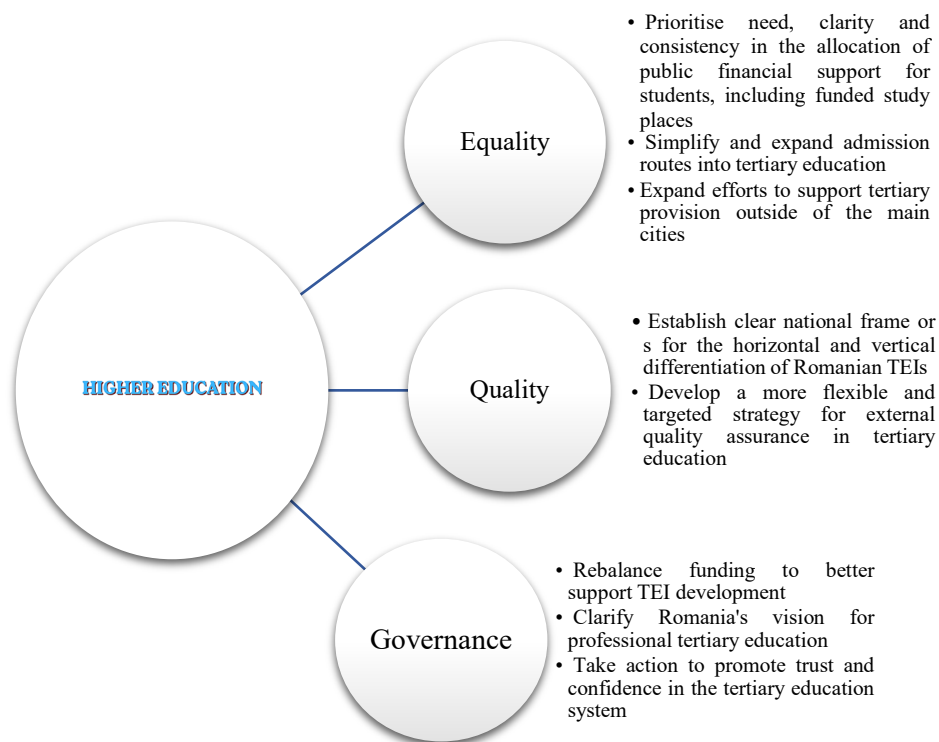


Figure 2. Summary of recommendations and actions regarding tertiary education in Romania

Source: Own elaboration based on OECD (2025)

The quality dimension emphasises the development of a clear national framework for the differentiation of higher education institutions and the implementation of more flexible and efficient mechanisms for external quality assurance. These recommendations aim to increase academic performance, improve the relevance of university programmes and strengthen the international competitiveness of Romanian universities. With regard to governance, the OECD recommends rebalancing funding mechanisms to support the institutional development of universities and clarifying Romania's vision for vocational tertiary education. It also highlights the need to expand university provision beyond major urban centres and to promote confidence in the higher education system. Overall, the recommendations reflect the need for integrated structural reform aimed at increasing access, quality and the economic relevance of higher education in Romania (OECD, 2025). The research findings confirm the relevance of human capital theory in explaining the relationship between education, employment and economic competitiveness. According to the approaches developed by Schultz and Becker, investment in education contributes to increased productivity and economic performance, and the data analysed for Romania highlight the fact that individuals with higher education enjoy significantly higher employment rates compared to those with lower educational levels (Zhang et al., 2026; OECD, 2024). This confirms the existence of significant economic returns associated with university education and supports the need to strengthen investment in human capital. At the same time, the results highlight the existence of a structural paradox in the Romanian labour market. Although the proportion of young people with higher education remains low and shows a downward trend over the period analysed, demand for highly skilled labour remains high, a fact reflected in the significant employment advantages enjoyed by tertiary education graduates (OECD, 2025). This situation confirms the observations made by Assaad et al. (2018) regarding the existence of imbalances between the skills provided by higher education institutions and the requirements of employers.

At the same time, the economic transformations brought about by globalisation and digitalisation require a re-evaluation of how human capital is defined and developed. In line with the perspective put forward by Deming and Silliman (2025), the contemporary labour market demands not only traditional cognitive skills, but also transversal skills, adaptability, collaboration and innovation. In this context, structural reforms in higher education are essential for increasing the relevance of university programmes and adapting them to the needs of the knowledge-based economy. The reform directions highlighted in Figure 1 and the OECD recommendations presented in Figure 2 support the need for an integrated approach to the development of higher education in Romania. Measures relating to performance-based funding, internationalisation, the strengthening of research partnerships and the development of industry-funded scholarships can help to increase graduates' employability and reduce the skills gap in the labour market. Furthermore, strengthening the relationship between universities and the business sector can support innovation and regional development, contributing to an increase in Romania's economic competitiveness (Petrescu, 2025; de Boer et al., 2017).

The research findings highlight that higher education reform can contribute significantly to reducing the existing mismatches between the skills provided by universities and the demands of the labour market in Romania. The implementation of measures such as performance-based funding, strengthening partnerships between universities and the business sector, internationalisation, and the development of industry-funded scholarships can support the employability of graduates and the adaptation of skills to current economic and technological transformations. At the same time, the results confirm that the development of human capital is an essential factor for economic competitiveness, and the modernisation of the university system is a necessary condition for reducing the shortage of highly skilled labour and for supporting sustainable economic development.

Conclusions

This research has highlighted the strategic importance of human capital development and higher education reform for increasing Romania's economic competitiveness. Analysis of Eurostat and OECD data has shown that Romania continues to have a low proportion of young people with higher education, despite the labour market exhibiting high demand for highly skilled labour. This situation reflects the existence of structural imbalances between the education system and the needs of the economy, as well as the need to implement reforms focused on performance, innovation and employability. The research findings confirm the relevance of human capital theory, according to which investment in education contributes to increased productivity and improved employment prospects. At the same time, the study highlights the fact that the transformations brought about by globalisation and digitalisation require universities to adapt to the new demands of the knowledge-based economy, by developing advanced skills and strengthening the relationship between the academic and economic spheres. In this context, the priority areas for reform analysed in the paper – outcomes-based funding, partnerships for innovation and research, internationalisation and the development of industry scholarships – can contribute to increasing the economic relevance of higher education and reducing the skills gap in the labour market. Furthermore, the OECD's recommendations highlight the need for an integrated approach, simultaneously focused on equity, quality and effective governance of the university system. However, the research also has certain limitations. The analysis was based predominantly on aggregate statistical indicators provided by Eurostat and the OECD, without including microeconomic data or empirical investigations conducted at institutional or regional level. Furthermore, the period analysed is relatively limited and does not allow for an assessment of the long-term effects of educational reforms on the labour market and economic competitiveness. With regard to future research directions, it is recommended that comparative studies be carried out between Romania and other European Union member states on the effectiveness of higher education reforms and their impact on graduate employability.

Furthermore, future research could analyse the relationship between digital skills, innovation and economic productivity, as well as the impact of collaboration between universities and the private sector on regional development and the retention of human capital in Romania.

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THE IMPACT OF FINANCIAL PERFORMANCE IN MERGERS AND ACQUISITIONS. EVIDENCE FROM THE REPUBLIC OF MOLDOVA.

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Abstract: *The performance of mergers and acquisitions (M&A) has become a frequent topic of academic debate. This research examines how capital structure, company size, and the level of indebtedness impact the performance of such transactions. The main objective is to determine which factors affect the return on assets in merger performance, focusing on the companies from the Republic of Moldova.*

Research methodology: *The quantitative research involves the systematization and grouping of data from financial statements provided by the National Bureau of Statistics for companies implicated in M&A, as well as multiple linear regression analysis to assess how changes in the Return on Assets (ROA) ratio depend on independent variables. Additionally, RStudio, Jasp, and Excel were used for statistical data processing, and the Web of Science database was used to identify relevant literature.*

Our findings *confirm the research objectives and questions using three multiple linear regression models, which validate the significant positive relationship between ROA and capital structure for the sample of acquirers. At the same time, net profit and gross margin are the factors that determine variation in ROA, as well as the pre-merger year for the sample of the acquirees, through an inverse relationship, validated using robustness tests.*

Keywords: *mergers and acquisitions (M&A); business combinations; financial performance.*

JEL: G34, Q56, M41, M48

Introduction

Mergers and acquisitions (M&A) represent a complex, multidimensional, and multidisciplinary field that drives investment and business consolidation on an international scale.

The flow of recent studies on this topic confirms the clear interest of the academic community and the business sector in quantifying the efficiency, quality, and predictability of these processes, thereby influencing managerial decisions and fostering synergies among the parties involved.

Recent publications describe the scope of an in-depth study on the factors influencing the initiation of an M&A process, as outlined by Wan L., Zheng Y., and others (Wan et al., 2026), which compared various regression analyses of Chinese firms as the main purpose. Researchers Loebiantoro I.Y., Dewi H. (Loebiantoro et al., 2025) and others investigate pre- and post – merger performance through the share market price and other similar indicators using a sample of listed companies in Indonesia.

Another line of research examines M&A performance in relation to Environmental, Social, and Governance (ESG) scores and the market value of acquirers (Kamiloğlu & Genç, 2026); (Zabawa et al., 2025) or with the value of the acquisition premiums (Laus et al., 2025).

Financial performances as described by economic and financial indicators, such as return on assets (ROA), firm size, and leverage ratios, can be found in the works of researchers Rufolo A. (Rufolo et al., 2025), Panda M. (Panda et al., 2025), or Podskabka T. (Podskabka et al., 2025).

The Romanian academic community is becoming more competitive thanks to the contribution by Chiriac I. (Chiriac & Rusu, 2025) regarding the business environment and the financial performance of M&A transactions in Europe, which similarly applies economic indicators such as ROA, return on equity (ROE), and net profit margin.

At the same time, the study of Romanian acquisitions that operate with discounts on M&A offers was the focus of authors Dragotă V. și R. Ciobanu (Dragotă & Ciobanu, 2017).

Previously, quantitative and qualitative empirical research has not been conducted in the Republic of Moldova. However, this topic was briefly addressed in the articles by Cojocaru M., Hromei A.S. (Cojocaru & Hromei, 2014), Grigori L., and Lazări L., which discuss the accounting treatment of business combinations in accordance with national and international regulations (Lazari & Grigori, 2016)

This paper presents a comprehensive analysis of the financial performance of companies involved in M&A transactions in the Republic of Moldova, by identifying the factors that influence managerial decisions leading to corporate mergers. To properly conduct the econometric modeling, the following indicators were tested: company size, capital structure, debt ratio, net profit, and gross profit margin. The purpose of this research is to conduct a descriptive and in- depth analysis of the financial indicators preceding and resulting from the M&A process and to assess their quality for enterprises in the Republic of Moldova

The scientific approach aims to explain the following research questions:

RQ1: How does the capital structure determine post-merger performance?

RQ2: What are the most significant economic and financial factors that determine the decision to merge in the business environment of the Republic of Moldova?

RQ3: How does the Year of the transaction determine the variation in return on assets?

The importance of studying M&A leads to a unique assessment of this process within the Republic of Moldova, as this is among the first studies of its kind in the sector. Moreover, it offers a highly relevant and unique contribution to the M&A process, shaped by the impact of the Covid-19 pandemic, followed by the conflict in the neighboring country and the current international instability resulting from shifts in the global economic landscape.

Basic content

The financial performance of M&A represents a distinct area of research for the academic sector.

In recent literature, the selection of control variables plays a critical role in isolating the effects of M&As. Researchers Bai Y., Zhang H. (Bai & Zhang, 2024), Chakraborty I., and Kattuman P. (Chakraborty & Kattuman, 2023) advocate the use of rigorous indicators, including operating profit margin, firm size (logarithmic), Tobin's Q ratio, and market density (number of companies)

Regarding the selection of the dependent variable, the use of return on assets (ROA) as a key measure of M&A efficiency is supported by the work of Lachwani V.M., Tiwan S., and Jauhari S. (Lakhwani et al., 2018). This demonstrates that ROA, along with net profit margin and asset turnover, contributes to the assessment of operational success. Results are based on 24 acquiring firms during the 2005-2006 period.

Inspired by the dynamics of the M&A market in Romania between 2010 and 2018, the author Aevoae G., M. (AEVOAE, 2024) designed a multiple linear regression model. The author uses the following variables: the number of shares controlled, the percentage stake acquired, the size of the target entity, and the accounting regulations in effect during that period.

Research methodology

Our study analyzes the effectiveness of M&A processes in the Republic of Moldova during the 2020-2025 period. This time section was marked by a series of external shocks, from the Covid-19 pandemic to the energy and logistics crises triggered by the conflict in Ukraine, which destabilized the domestic business environment. The study aims to assess the relevance of the ROA ratio as a post-merger performance metric, while also investigating the correlation between capital structure, firm size, and the quality of these transactions

The purpose of the exercise is to assess the quality of M&A grouped by company categories: acquirers in the corporate and state sectors, and acquirees. The data collected covers a 375-enterprise sample, structured by 164 acquirers, then 209 acquirees, and only 2 companies were merged by consolidation.

The information was selected from publicly available financial statements from the National Bureau of Statistics for the years preceding and concurrent with the transaction.

Drawing inspiration from the research of Rufolo A. (Rufolo et al., 2025), Panda M. (Panda et al., 2025), Podskabka T. (Podskubka et al., 2025), and Chiriac I. (Chiriac & Rusu, 2025), we define the dependent variable: return on assets (ROA), to observe the performance of M&A.

To measure the pre- and post-merger effects, the independent variable Year was selected as binary (dummy), which means the value 1 represents the merger termination process year, and 0 the preceding year. This variable identifies the pre- and post- mergers effects, as well as the resulting economic indicator arising from the consolidation of assets, liabilities, and equity by the companies.

Table 1 presents all the variables selected in the study

Table 1: Variables used in analysis

Variable type	Symbol	Representation	Explanation
Numeric, dependence	ROA	Net profit ÷ Total assets	> ROA – efficient uses of assets, < ROA – inefficient investment uses of assets
Numeric, independence	PN	Net profit	The final result of the activity
Numeric, controlling	Capital	Ln (Equity)	The structure of capital
Numeric, controlling	Liabilities	Ln (Total liabilities)	Leverage
Numeric, controlling	Active	Ln (Total assets)	Company size
Numeric, independence	Gross marginal	(Sales revenue – Cost of sales) ÷ Sales revenue	Cost coverage ratio form sales
Numeric, independence	Ira	Sales revenue ÷ Total assets	> 1 efficiency in the management of total assets < 1 – inefficiency in the management of total assets
Dummy	Year	Year of M&A	1 – completed M&A 0 – the year before the M&A

Source: The author's own data.

The following multiple linear regression models were selected as mathematical decisive solutions:

The ROA efficiency model applied to the sample of state-owned institutions:

$$ROA_{public} = \alpha + \beta_1 (Capital) + \beta_2 (Ira) + \beta_3 (PN) + \beta_4 Year + \varepsilon$$

The ROA efficiency model employed for the sample of acquirers in the corporate sector:

$$ROA_{corporative\ sector} = \alpha + \beta_1 (Capital) + \beta_2 (Liabilities) + \beta_3 (Gross\ margin) + \beta_4 Year + \varepsilon$$

And, the ROA efficiency model for the acquirees:

$$ROA_{acquirees} = \alpha + \beta_1 (Active) + \beta_2 (Capital) + \beta_3 (Gross\ margin) + \beta_4 Year + \varepsilon$$

The analysis of the research questions and econometric models was conducted in RStudio, Excel, and JASP tools.

Research results

The three multiple linear regression models are successively verified, validated, and tested using model performance analysis, robustness, and tests for multicollinearity, heteroscedasticity, and residual variation. The data and results are compared between them.

On the one hand, given the relationship with the market size, and on the other hand, with the level of profit, return on assets is an indicator that defines an entity's ability to generate profit by investing in its assets. Initially, using Excel functions, the collected data have been tested in multiple linear

regression models. After several adjustments, exclusions, and verifications, the indicators presented in Table 1 are appropriate and suitable.

The analysis of ROA is defined by the gross margin, the capital structure, which, to reduce data dispersion, is mathematically transformed into the natural logarithm of equity, the firm size (logarithm of total assets), the asset turnover ratio, and the binary variable „Year”, representing the current or preceding merger year.

Descriptive statistical data for the variables are presented in Table 2 for the state-owned acquirers, in Table 3 for those in the corporate sector, and in Table 4 for the acquirees, respectively.

Table 2: Descriptive statistics for state-owned acquirers

Variable	Minim	Maxim	Media	Standard error	Median	Kurtosis	Nr. Observ.
ROA	-1,25	0,36	-0,02	0,20	-0,01	16	72
PN	-71654579,0	43629366,0	-4652290,83	19550963,49	-96202,50	3,99	72
Ira	0,0000	12,81	1,81	2,45	0,88	6,85	72
Capital	0,0000	10,13	6,79	2,23	6,99	3,29	72
Year	0,0000	1,0000	0,47	0,50	0,0000	-2,02	72

Source: Author's processing

Table 3: Descriptive statistics for corporate sector acquirers

Variable	Minim	Maxim	Media	Standard. error	Median	Kurtosis	Nr. Observ.
ROA	-3,72	1,98	0,03	0,39	0,04	43,91	252
Gross margin	-2,63	1,00	0,28	0,37	0,20	14,83	252
PN	-167120681,0	1.127483	15158155,45	86211783,93	454842,50	114,25	252
Capital	0,00	9,74	6,17	2,53	6,91	1,65	252
Year	0,00	1,00	0,52	0,50	1,00	-2,00	252

Source: Author's processing

Table 4: Descriptive statistics for acquirees

Variable	Minim	Maxim	Media	Standard. error	Median	Kurtosis	Nr. Observ.
ROA	-1357,09	8173,91	16,38	337,01	0,00	528,43	649
Gross margin	-5794,15	1,38	-8,72	227,45	0,16	642,00	649
Liabilities	0,000	10,84	5,35	2,96	6,38	-0,46	649
Active	0,00	10,47	6,49	2,14	6,85	3,43	649
Year	0,00	1,00	0,46	0,50	0,00	-1,97	649

Source: Author's processing

As we mentioned, the main goal of this study is to evaluate M&A performance by looking at the variables that affect ROA. Consequently, all three models are calculated using the ordinary least squares (OLS) method, which estimates the values of return on assets ROA determined by indicators such as changes in net profit, gross margins, firm size (defined by the logarithm of total assets), equity structure, debt ratio (logarithms of liabilities), and asset turnover, as well as the year.

The results obtained for these three models are presented in Table 5

Table 5: Coefficient values for the ROA models

Variables	ROA state-owned acquirers			ROA corporate sector acquirers			ROA acquirees		
	Coef. β	Standard Error	P> t	Coef. β	Standard Error	P> t	Coef. β	Standard Error	P> t
Intercept ε	-0,1276	8.198	0,12443	-0,282	7.005	0.00128**	30.39		0.035*
Gross margin				0,1521	6.419	0,01861*	-1.41720	-79138	<0.001***
Liabilities							-	3.22295	0.001***
Active							11.03649		
Capital	0,02771	1.052	0,01046*	0,0383	9.599	<0.001***	7.17767	3.34321	0.032171*
PN	0,000032	1.132	0,00508**	0.00034	2.828	0.90439			
Ira	-0,02407	9.491	0,01356*						
Year	-0,03548	4.287	0.41082	-0,03662	4.780	0.44436	-	8.24231	0.068638
Nr. observations		72			252		15.03278		
R ² and R ² adjust	0,269		0,226	0,0875		0,0727	0.9078		0.9072
F statistic	6.174				5.921			1585	
p-value	0.0002728				0.001448			0.0000022	

Note: Significant codes: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' ', 1

Source: calculations performed using RStudio.

The econometric model estimates for the state-owned institutions sample involved in Merger processes demonstrate a statistically significant ability to explain the variance in ROA. The model's validity is confirmed by the F-test ($p < 0,001$), while the coefficient of determination ($R^2 = 0,26$) indicates that approximately 26% of the variation in ROA is explained by the selected predictors. The intercept is -0,13, falling within the 95% confidence interval [-0,29; 0,04]. Analysis of the individual parameters reveals the following:

Asset turnover efficiency: The asset turnover ratio has a negative and statistically significant impact on performance ($\beta = -0,02$; $p = 0,014$). This inverse correlation suggests that an increase in asset turnover within state-owned institutions is associated with a marginal decline in profitability.

Capital structure: Equity (log-transformed) has a positive impact on ROA ($\beta = 0,03$; $p = 0,010$). Although the coefficient's slope is small, this is due to the logarithmic transformation of the variable, which smooths out the variation and scales the marginal impact of equity on return.

Net Profitability: the variation in net profit is a direct and positive determinant of ROA ($\beta < 0,001$ and $p = 0,005$). The result confirms that the profitability ratio is structurally dependent on the amount of profit generated.

Time variable: The year of the merger does not have a statistically significant influence on ROA performance ($\beta = -0,04$; $p = 0,411$), suggesting the absence of a trend effect or immediate periodicity in the analyzed data.

Statistical significance was assessed via the t-distribution approximation (Walt test), using the RStudio statistical programming environment.

For the corporate sector, the regression model was estimated similarly, using the ordinary least squares (OLS) method, with gross margin, capital structure, net profit, and the time variable (Year) as independent variables. Although the model has a modest coefficient of determination ($R^2 = 0,0875$), it remains statistically significant ($p < 0,001$). The low value of R^2 suggests that ROA in the private sector is influenced by a wide range of exogenous factors not included in the current

specification; however, the selected variables remain relevant predictors. The model's constant is -0,23 ($p = 0,0001$), indicating a baseline level of negative profitability in the absence of the predictors' influence.

The components of the model highlight the following trends:

Gross margin: There is a positive and significant impact on ROA, with an elasticity of 0,15 ($p = 0,019$). The result confirms that optimizing production costs and increasing the gross margin are the key drivers of ROA.

Capital structure: Capital structure has a significant positive effect ($\beta = -0,04$; $p = 0,001$). From an economic perspective, the coefficient indicates that a one-unit increase in capital (as measured by the financial proxy used) results in a quantitative improvement in ROA.

Insignificant factors: Unlike in the previous model, net profit and the year of the merger do not result in statistically significant ROA changes in this sample; the p -values exceed the critical level of 0,05. These findings highlight greater heterogeneity in corporate sector performance with regard to these indicators.

In conclusion, both models support the hypothesis that market capitalization and profit margin are the main contributors to ROA following a merger, while time-dependent variables remain neutral during the intermediate stages of the reorganization process.

Next, we will test the ROA model for acquirees that publish their final financial statements before the merger.

In terms of predictive power, the last model is the most robust in this research, exhibiting a substantial coefficient of determination ($R^2 = 0,907$) and a high overall statistical significance ($p < 0,001$). This R^2 value indicates that approximately 90,7% of the variation in ROA is explained by the variables included in the study. The intercept has a value of 30,38 and is statistically significant ($p = 0,00026$). A detailed analysis of the coefficients reveals the following correlations:

Firm size (log-transformed): The size of acquirees has a positive and statistically significant influence on ROA. The β coefficient of 3,34, at a significance level of $p = 0,032$, confirms that larger firms (in terms of total assets), achieve higher returns on assets in the pre-merger period or are attractive to acquirers.

Liabilities level (expressed logarithmically): similar to firm size, the level of liabilities has a significant positive impact on performance ($\beta = 3,22$; $p = 0,001$). This result suggests that acquirees make effective financial use of leverage, where the raising of external funds has contributed to optimizing capital efficiency.

Gross margin: The gross profit margin has a statistically significant effect, but one that is inversely proportional to the dependent variable ($\beta = -7,9138$; $p < 0,0001$). The extremely steep negative slope indicates a high sensitivity of ROA to fluctuations in gross margin in this specific sample, suggesting possible inefficiencies in the management of direct operating costs.

Temporal variation (Year): Consistent with previous models, the time factor does not exert a statistically significant influence on ROA variance, confirming the structural stability of the model over the analyzed period.

In order to ensure the robustness of the results and to stabilize the variation, the variables related to size, liabilities, and capital structure were subjected to logarithmic transformation, a procedure essential in modeling heterogeneous financial data. The findings obtained through the RStudio tool validate the hypothesis that the performance of acquirers and acquirees was governed by their ability to scale and by their capital structure management strategies prior to consolidation.

However, the final validation of the econometric models involves a comprehensive analysis, including the application and verification of tests for normality, heteroscedasticity, multicollinearity, and variable robustness, as presented in Table 6.

Table 6: Results of econometric tests on the ROA models

Model type	ROA owned-state acquirers	ROA corporate sector acquirers	ROA acquirees
P-value	0,0002728	0,0001448	<0,0001
F-statistic	6.174	5.921	1585,381
R ²	0,2693	0,0875	0,908
R ² adjust	0,2257	0,07272	0,907
Shapiro – Wilk Test (residuals)	Partially uniform, W= 0,8983282 p-value = 0.0026246	Non-uniform W= 0,4997955 p-value < 0.0001	Non-uniform, W= 0,1331846 p-value < 0.0001
Dublin – Watson Test	Yes DW = 1,3842, p-value = 0,002811	Yes DW = 1.8587 p-value = 0,1292	Yes DW = 1,9929, p-value = 0,4653
Breusch-Pagan Test Homoscedasticity	Non BP=37.795 $\chi^2 = 81.59728$ DF=1	Non, BP=17.842 $\chi^2 = 318.7137$ DF = 1	Non, BP= 18.735 $\chi^2 = 1.93774$ DF = 1
Multicollinearity	Weak for all predictors (1.01-1.20) <5	Weak for all predictors (1.003-1.045) <5	Weak for all predictors (1.02-3.14) <5

Source: calculations performed using RStudio.

The ROA models analyzed for the three categories of companies verify the heteroscedasticity, multicollinearity, and autocorrelation tests. The only test that yields different results is the Shapiro-Wilk test regarding the normal distribution of the residuals. The residual normality can be achieved for a sample of up to 100 observations. In this case, the sample of own-state institutions alone consists of 72 observations. However, the test results confirm a partial uniformity of results.

Discussion

This research acknowledges the typological and methodological diversity of the regression models employed in the economic literature. However, the models underlying this scientific endeavor were specifically designed to assess the dynamics of the ROA in the context of mergers in the Republic of Moldova, representing an original and unique empirical contribution to the local academic literature. The validation of these results is corroborated by reference studies demonstrating that, in the analysis of real financial data, deviations from standard assumptions of normality or homoscedasticity do not necessarily validate the robustness of estimates. According to research conducted by Gu Y. and others (Gu et al., 2025), the effect of independent variables in complex models can be significant even in the absence of a normal distribution of residual values, suggesting the presence of specific determining factors that may require alternative forms of statistical data treatment.

A key robustness indicator of the analyzed models is the p-value, which, for all three estimated equations, falls below the critical level 0,001. This value indicates a very high probability of a significant relationship between the dependent variable ROA and the set of selected independent variables. The significance of the research reported by Fuad J. (Fuad & Jatmiko, 2022) and Agyei-Boapeah (Agyei-Boapeah et al., 2019), reinforces confidence in the predictive power of the analysis. The exploratory performance of the models varies depending on the specific characteristics of the samples analyzed, offering different perspectives:

- Acquirees Model: demonstrates exceptional predictive power, with a coefficient of almost complete determination of approximately 90%, reflecting an almost complete determination of performance based on the selected pre-merger factors.
- Owned-state Acquirers: have an R^2 of 27%, a value considered robust in applied econometric studies for the public sector.
- The corporate sector ROA model: although it shows a coefficient of 8,7%, it remains statistically significant, indicating that, while performance in the private sector is influenced by a multitude of exogenous factors, the variables included in the model retain a relevant explanatory role

In conclusion, from an econometric standpoint, for all the models analyzed, the probability that the relationship between the selected financial indicators is purely coincidental is less than 0,1%, which demonstrates the scientific value of the research.

At the same time, for the corporate sector acquirers, the factors that directly influence the decision to merge are much more sophisticated, which suggests that we should broaden our scope to include organizational culture, technological integration, post-merger management, and merger premiums. Confirming homogeneity (or appropriately handling heteroscedasticity, where applicable) ensures that error variance does not distort the results. The graphical representation of the results of the residual and model variation, illustrated in Figure 2, provides a visual validation of the stability of the identified relationships, demonstrating that the models are capable of capturing the economic regularities of M&A in the Republic of Moldova.

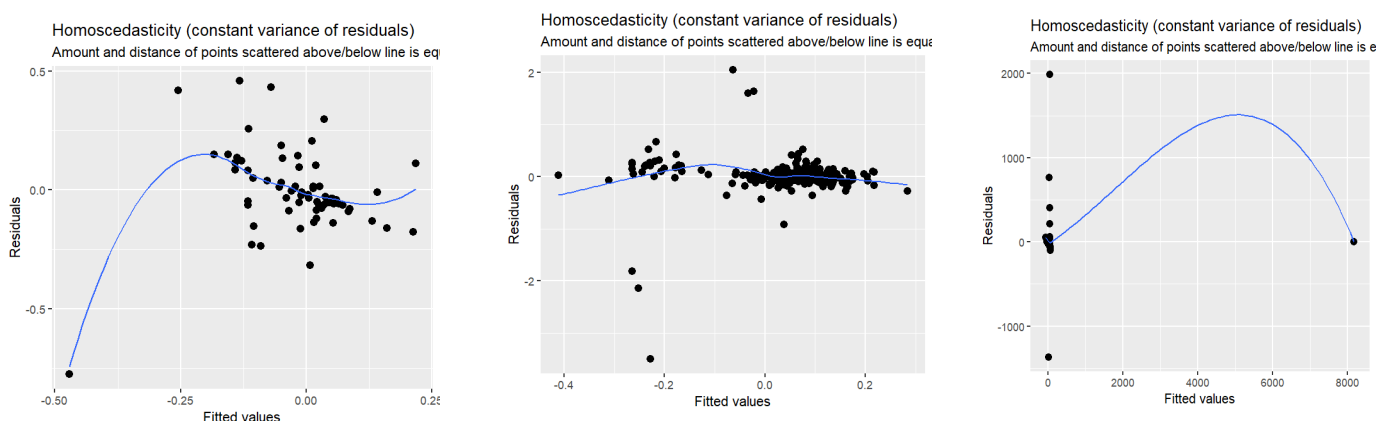


Figure 2: heteroscedasticity of the ROA models

Source: Author's own creation using the RStudio tool.

Consequently, the variance of the residuals remains constant across the values of the independent variables, and the absence of the „funnel” in the residual plot for all three models confirms homoscedasticity, as further supported by the residual of the Breusch-Pagan test. Although the residual distribution plot for the sample of corporate sector acquirers displays slight forms of heteroscedasticity, the formal Breusch-Pagan test confirms the stability of the variance, which validates the application of the OLS method.

Furthermore, collinearity verifies the degree of correlation or influence of the independent variables on ROA. The results of the test confirm the effectiveness of the predictor selection, as illustrated in Figure3.

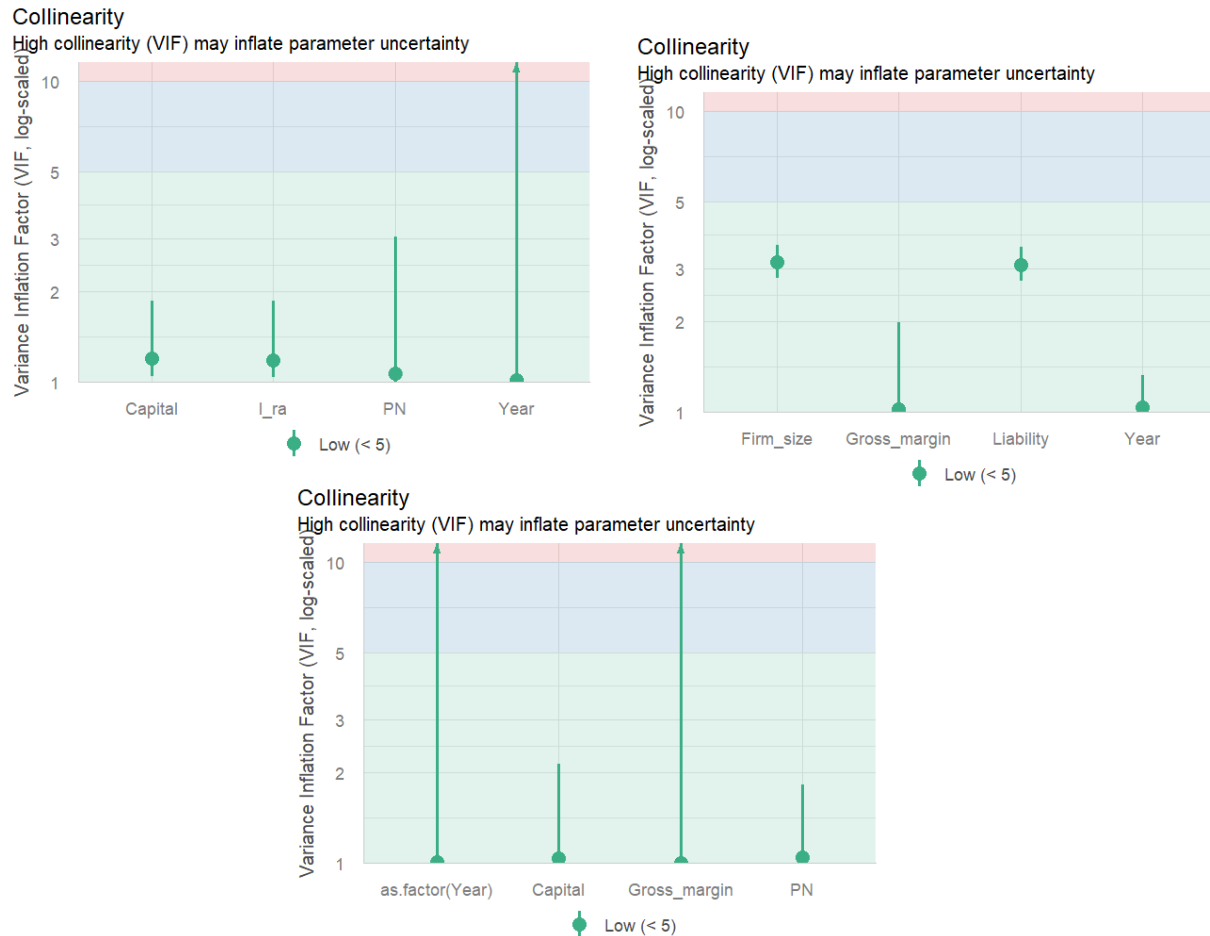


Figure 3: Multicollinearity test ROA models
 Source: Author's own creation using the RStudio tool

Thus, factor loadings below 5 indicate that the variables selected in the respective models measure distinct aspects of the activity, thereby providing a coherent representation of reality. An additional step in verifying the degree of factor influence consists of applying variable robustness tests, which validate the research RQ2 question through Table 7.

Table 7: Variable robustness test for ROA models

Variables	ROA own-state acquirers Coef. β HCI	ROA corporate sector acquirers Coef. β HCI	ROA acquirees Coef. β HCI
Gross margin		0,152***	-1,417***
Capital	0.028**	0,038**	
PN	< 0,001***		
Year			-15,033*
Intercept ε	-0,128*		

Note: significant code: 0 '***', 0.001 '**', 0.01 '*', 0.05 '.', 0.1 ' ', 1

Source: calculations performed using RStudio

Therefore, the return on assets analyzed based on the sample of state-owned institutions is determined by the positive variance of capital (estimated using logarithms) and net profit, while the assets

turnover ratio becomes secondary and insignificant. For private acquirers, the same results hold; gross margin and capital continue to determine ROA. For acquirees, firm size (estimated in logarithms of total assets) and liabilities ratio (log-transformed) become irrelevant, but the decline in gross margin and pre-merger performance significantly determine M&A performance.

Thus, the factors that determine managerial decisions regarding business mergers in the Republic of Moldova are: capital, gross margin, net profit, and the pre-mergers year, which provides the answer to research question RQ2. Finally, the normality test – the Shapiro-Wilk test- verifies the uniform distribution of errors or residuals. For all models examined, due to the extremely low p-values, the null hypothesis is rejected, as presented in Figure 4.

Although classical least squares theory assumes the normality of validation errors, the F and t tests, in economic practice, particularly for the samples analyzed, the number of observations is quite large, justified by the presence of extreme values specific to the emerging market in the Republic of Moldova. However, the considerable sample size endures the asymptotic robustness of the OLS estimator, allowing for a valid interpretation of the results obtained.

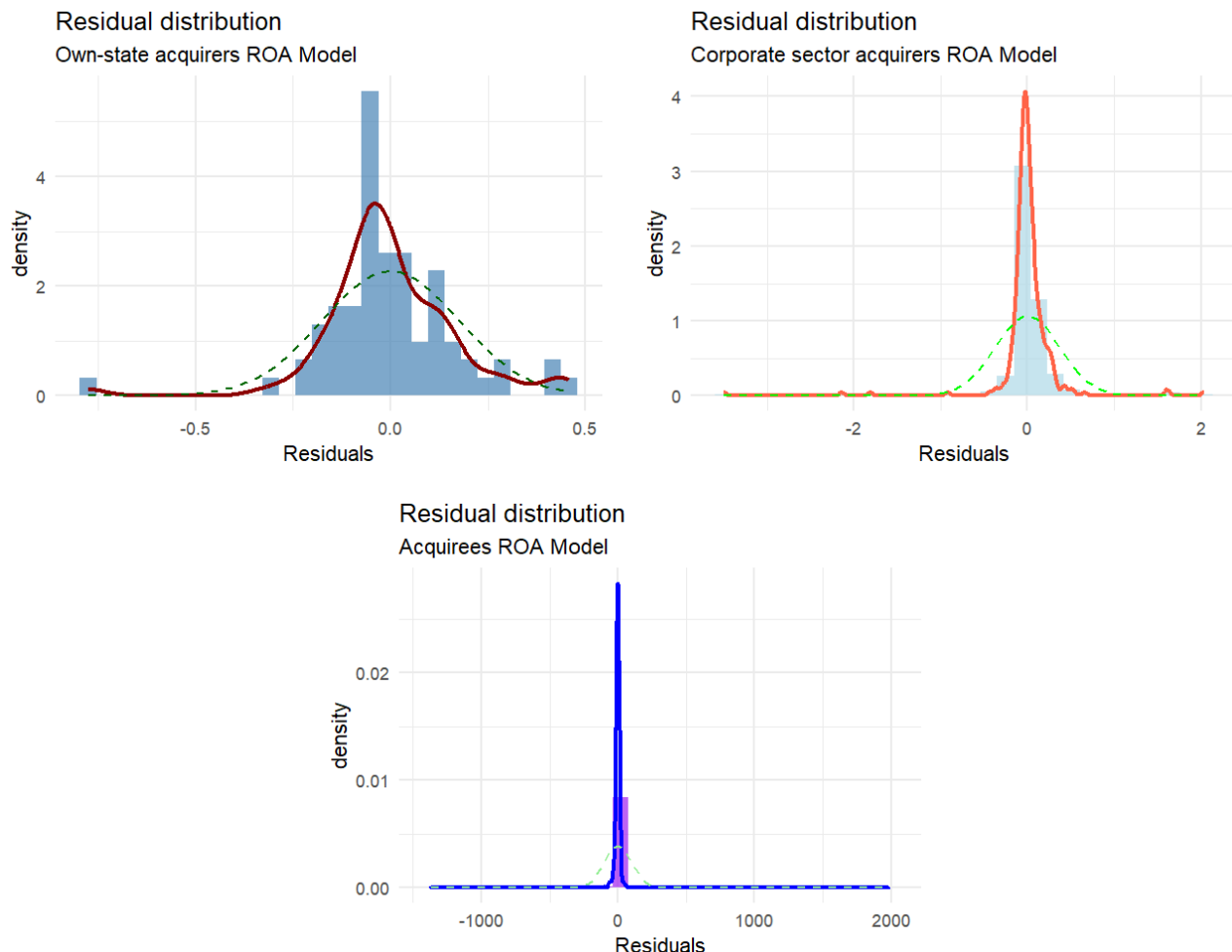


Figure 4: Residual distribution of the ROA models

Source: Author's own creation using the RStudio tool.

Consequently, the purpose of this study is to address the research questions outlined in the introduction. Thus, the capital of acquirers in both samples significantly influences decisions to initiate and carry out mergers, as evidenced by the positive coefficients in the respective models (0,028 and 0,038). Applying a logarithm transformation to equity facilitated the attainment of realistic

results reflecting the situation in the emerging economy of the Republic of Moldova, while also mitigating the non-normality of the row data, reducing its skewness, and demonstrating the scientific validity of the results. Therefore, RQ1 is present in the sample of acquirers and validates the importance of this indicator for the analysis.

Similarly, research questions RQ1 and RQ2, regarding the year of the merger, present, based on both model results and robustness analyses, that they do not have a direct influence on ROA variation, although for acquirees, the pre-merger year significantly contributes to the quality of information contained in the financial statements and to pre-and post – merger years do not produce significant changes in short-term ROA variation, given the results obtained from the models.

In conclusion, the objective of the research was fully achieved, and the findings are satisfactory.

Conclusions

This paper provided a comprehensive econometric analysis of the performance of M&A processes in the Republic of Moldova, using three distinct regression models. The results support a series of valuable conclusions for both academic and policy communities.

First, the validity of the estimated models is supported by rigorous diagnostic tests. The absence of multicollinearity and the confirmation of homoscedasticity of the results for most samples guarantee the stability of the OLS estimators. Although the Shapiro-Wilk test indicated deviation from normality of the errors, the sample size and asymptotic robustness allow to validate interpretation of the identified relationships.

Second, the analysis of determinants highlights the vital role of capital structure and gross margin. Equity for acquirers becomes a pillar of asset profitability stability. The identified positive correlation suggests the success of the local market merger depends on adequate capitalization, capable of absorbing the shocks of the process.

A notable aspect is the role of the time variable. Although most of these models did not present a statistically significant influence on ROA, robustness tests reveal a negative dependence, explained by the likelihood of asset profitability erosion in the pre-merger year.

Finally, the paper demonstrates that, in the context of the Moldovan economy, ROA is not a random phenomenon but is determined by financial fundamentals. The proposed models, validated by robustness tests and supported by remarkable predictive power (especially for state-owned institutions and acquirees), constitute a useful analytical tool.

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INVESTIGATING THE ISSUES ARISING FROM THE INTEGRATION OF BLOCKCHAIN TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE INTO ACCOUNTING AND AUDITING PRACTICES

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Abstract. *The integration of emerging technologies into accounting and auditing represents a major global challenge, reflecting the ability of financial and organizational systems to adapt to digitization processes. In this context, blockchain technology is considered a key driver of digital transformation, contributing to the redefinition of accounting practices and the enhancement of the reliability of financial information. This study analyzes recent literature on the use of blockchain technology in accounting and auditing, highlighting the main research directions, methodologies used, and implications for professional practices. The research explores how this technology influences accounting and auditing processes, as well as the relationship between digitization, automation, and increased transparency of financial information. The results indicate that blockchain facilitates the development of real-time accounting and continuous auditing, contributing to increased data security and process automation. At the same time, integration with artificial intelligence improves analytical capabilities and risk identification processes. However, the implementation of this technology highlights the existence of persistent challenges related to the regulatory framework, implementation costs, and the level of digital skills. The analysis highlights that blockchain acts as a structural driver of accounting transformation, but its effectiveness depends on the alignment between technological development, the institutional framework, and the adaptation of professional practices.*

Keywords: *blockchain technology, accounting, auditing, artificial intelligence, digital transformation, data security*

JEL: M41, M42

Introduction

Digital transformation represents one of the most significant challenges facing the accounting field in the context of the modern economy, characterized by the intensive use of emerging technologies. In this regard, blockchain technology, alongside artificial intelligence, is considered a major disruptive factor, capable of redefining how financial information is collected, processed, and reported [1, 2]. The emergence of these technologies marks the transition from traditional accounting

systems, based on manual processes and ex-post verifications, to integrated digital systems characterized by automation and real-time access to information.

Blockchain stands out for a number of key features, such as decentralization, transparency, and data immutability, which help increase trust in financial information and reduce the risk of fraud [3, 4]. By using distributed ledgers, transactions can be recorded and verified in real time, thereby facilitating the development of a continuous accounting system and automated auditing. Furthermore, the integration of blockchain with artificial intelligence enables the analysis of large volumes of data and the rapid identification of anomalies, contributing to improved decision-making [1].

The literature highlights a significant increase in interest in the use of blockchain technology in accounting and auditing, particularly in recent years, against the backdrop of the accelerated digitization of the economic environment [5]. Recent studies highlight both the benefits of implementing this technology—such as increased transparency, efficiency, and data security—and the associated challenges, such as the lack of a regulatory framework, high costs, and difficulties in integrating with existing systems [6, 7, 8]. Furthermore, the adoption of blockchain entails significant changes in the role of accounting professionals, requiring the development of digital skills and adaptation to new technological requirements.

In this context, the aim of this research is to analyze recent contributions in the literature regarding the use of blockchain technology in accounting and auditing, highlighting the main research directions, the methodologies used, and the impact on professional practices.

The specific objectives of this paper are: O1: To identify the main research directions regarding the use of blockchain in accounting and auditing; O2: To analyze the methodologies used in recent studies and the results obtained; O3: To assess the impact of blockchain technology on accounting and auditing practices.

The State of Research on the Integration of Blockchain and AI Technologies in Accounting and Auditing

To achieve the proposed objectives, the research is based on an analysis of recent specialized literature on the use of blockchain technology in accounting and auditing. The studies included in the analysis reflect a variety of perspectives on the integration of this technology, covering both theoretical approaches and empirical investigations [1].

The selection of studies took into account their relevance to the research topic and their contribution to understanding the impact of blockchain on accounting and auditing practices. In this regard, studies highlighting the benefits and limitations of the technology [3] were considered, as well as research analyzing the determinants of its adoption in the organizational environment [6]. Additionally, papers capturing the evolution of research in the field and the main directions of development [5] were included. The results of the analysis are summarized in Table 1, which highlights the main contributions of recent studies in terms of the phenomenon under study, the research objective, the methodology used, as well as their results and impact on the field of accounting. The analysis also reveals the diversity of methodological approaches and the complexity of the phenomenon under study [7].

Table 1. Summary of recent studies on the use of blockchain technology in accounting and auditing

AUTHOR(S) (YEAR)	SUBJECT STUDIED	PURPOSE	METHODOLOGY	RESULTS	IMPACT
HAN ET AL. [1]	Integration of blockchain technology and artificial intelligence in accounting and auditing	Analysis of how blockchain improves transparency, trust, and decision-making in accounting and auditing	Review of the literature	Blockchain enables real-time accounting, continuous auditing, and improves data quality and reliability	Reduces information asymmetry and supports the development of automated auditing and digital ecosystems

PUTRITAMA ET AL. [3]	The Impact of Blockchain Technology on Accounting, Auditing, and Financial Reporting	Analysis of the transformative role of blockchain in accounting and identification of research directions	Review of the literature	Blockchain increases data transparency, security, and efficiency, but poses integration and regulatory challenges	Supports accounting innovation and highlights the need for standardization and future research
AKTER ET AL. [6]	Adoption of blockchain technology in accounting	Identifying factors influencing blockchain adoption and associated challenges	Empirical study based on interviews	Adoption is influenced by organizational factors, high costs, lack of knowledge, and integration difficulties	Provides empirical evidence on adoption barriers and supports organizational decisions
PARRA-DOMÍNGUEZ ET AL. [2]	The disruptive impact of blockchain technology on accounting practices	Analysis of how blockchain is transforming accounting and identification of trends and gaps in research	Systematic literature review and bibliometric analysis	Blockchain improves transparency, security, and automation and integrates with AI, while also highlighting implementation challenges	Provides future research directions and supports the development of the theoretical and practical framework of digital accounting
ZHANG ET AL. [9]	The impact of blockchain technology on the audit process	Assessment of the benefits and risks of blockchain in auditing	Systematic literature review and case study analysis	Blockchain improves audit efficiency and enables continuous auditing, but presents technical risks and regulatory limitations	Highlights the need to develop the legislative framework and professional competencies
HASSANEIN ET AL. [5]	The evolution of research on blockchain technology in accounting and auditing	Mapping the specialized literature and identifying trends and research directions	Bibliometric analysis	The research highlights the rapid growth of interest in blockchain in accounting and auditing, identifying the main research directions and collaboration networks concentrated among authors and institutions	It contributes to shaping future research directions and highlights the need to develop the theoretical framework and of empirical studies on the integration of blockchain and AI
GKEKAS ET AL. [10]	Adoption of blockchain technology in accounting and auditing services	Analysis of factors influencing the intention to adopt blockchain	Empirical study and structural equation modeling	Adoption is influenced by moral values, social norms, attitude, and perceived behavioral control	Provides insights for developing strategies to implement blockchain in organizations
SHAHWAN ET AL. [11]	Auditors' perceptions of the use of blockchain technology in	Identification of blockchain's advantages and challenges from the	Empirical study and statistical analysis	Blockchain is perceived as increasing transparency, but there are	Highlights the influence of organizational culture on the adoption of

	accounting and auditing	auditors' perspective		differing opinions regarding other benefits	blockchain in auditing
LIMA E SILVA. [4]	The use of blockchain technology in accounting and auditing	Analysis of How Blockchain Enhances Transparency, Efficiency, and the Audit Process	Review of the literature	Blockchain enables continuous auditing, automates processes, and reduces fraud, but presents integration and regulatory challenges	Supports the strategic implementation of blockchain and the improvement of financial reporting quality
HAMADEH ET AL. [12]	Auditors' intention to adopt blockchain technology	Analysis of factors influencing blockchain adoption using the TAM model ³	Empirical SEM modeling study	Auditors are more willing to adopt blockchain if they consider it useful for their work and easy to use	Highlights the need for professional training and infrastructure development for blockchain adoption
JENA [7]	Factors influencing the adoption of blockchain technology in accounting and auditing	Prioritization and classification of determinants of blockchain adoption	Qualitative approach based on MCDM methods	Adoption is primarily influenced by management support and government backing	Provides support for strategic decisions regarding blockchain implementation in organizations
ARICIU ET AL. [8]	The use of blockchain technology in accounting and auditing practices	Analysis of empirical research and identification of gaps and future directions	Systematic literature review	Blockchain transforms professional roles and highlights the need to develop technical skills	Provides research directions and supports the adaptation of organizational strategies to digitalization

Source: Authors' compilation based on the specialized literature

An analysis of the studies presented in Table 1 highlights a significant increase in research on the use of blockchain technology in accounting and auditing, reflecting the academic community's growing interest in the impact of these emerging technologies on professional practices. The specialized literature consistently emphasizes the transformative role of blockchain, highlighting its contribution to increasing the transparency and security of financial information [1]. At the same time, the use of distributed ledgers enables the recording and verification of transactions in real time, a feature that leads to improved data traceability [3].

A primary direction identified in the analyzed literature is represented by conceptual studies and literature reviews, which highlight the benefits of implementing blockchain in accounting and auditing. This research reveals that the technology facilitates the development of real-time accounting and continuous auditing, contributing to increased efficiency in accounting processes [2]. At the same time, the automation of repetitive tasks leads to a reduction in errors and the optimization of operational workflows [4]. The integration of blockchain with artificial intelligence is frequently cited as a key factor in the development of advanced financial analysis and control systems [1].

A second area of research consists of empirical studies, which offer an applied perspective on the adoption of blockchain technology. Their results indicate that the implementation of this technology is influenced by a combination of technological, organizational, and behavioral factors. Thus, high costs and the complexity of integration represent significant barriers to adoption [6]. At the same

time, perceived utility and ease of use directly influence the intention to adopt blockchain [12]. Furthermore, social and ethical factors, such as moral values and organizational norms, play an important role in the decision-making process [10], while management support and the institutional framework contribute to facilitating implementation [7].

At the same time, the literature highlights the existence of structural challenges that limit the widespread adoption of blockchain technology. These include a lack of digital skills among accounting professionals and difficulties in integrating with existing IT systems [6]. Furthermore, the absence of a clear regulatory framework adapted to new technologies represents a major obstacle to expanding the use of blockchain in practice [9].

Another relevant category of studies consists of bibliometric analyses, which provide an overview of the evolution of research in this field. These works highlight a rapid increase in interest in blockchain technology and identify the main research directions, emphasizing the need to develop more robust theoretical and methodological frameworks [5].

Conclusions

The analysis conducted highlights that blockchain technology is a key driver in the digital transformation of accounting and auditing, contributing to the redefinition of how financial information is collected, processed, and reported. Through its fundamental characteristics, this technology enables increased transparency, security, and reliability of data, while facilitating the development of modern accounting systems based on real-time recording and continuous auditing.

The research findings also highlight that integrating blockchain with other emerging technologies, such as artificial intelligence, enhances the capacity for analysis and risk identification, contributing to increased efficiency in decision-making processes. In this context, the role of the accounting professional is undergoing significant changes, requiring a shift toward activities involving a higher degree of analysis and interpretation of information.

However, the implementation of blockchain technology remains limited by a number of challenges, such as the lack of an adequate regulatory framework, high implementation costs, and insufficient development of digital skills. These issues highlight the need for an integrated approach that includes both technological adaptations and organizational and educational changes.

Thus, blockchain technology offers significant opportunities for modernizing accounting and auditing, but fully realizing this potential depends on the ability of organizations and professionals to adapt to the demands of a constantly evolving digital environment. Thus, the future of the accounting field is closely linked to the integration of emerging technologies and the development of skills suited to new economic realities.

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FINANCIAL REPORTING QUALITY AS A DRIVER FOR ACCESSING EXTERNAL FINANCING

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Abstract: *Within the financial market of the Republic of Moldova, which is heavily dominated by the banking sector in the absence of a fully developed capital market, the informational gap between companies and creditors represents a major structural obstacle to securing external financing. This research employs a methodology based on qualitative synthesis and a critical-comparative analysis of national and international literature, evaluating the transmission channels of agency theory (adverse selection and moral hazard) in correlation with financial reporting regimes. The findings reveal that the credit market in the Republic of Moldova remains constrained by the paradigm of asset-based lending (collateral-driven), a direct response to the opacity and formalism of financial statements prepared under National Accounting Standards (NAS). However, the analyzed evidence demonstrates that the transition to IFRS acts as a catalyst for enhancing Financial Reporting Quality (FRQ), providing superior predictability of cash flows and enabling a shift toward modern bank screening models (centered on IRR and financial performance). The study concludes that mere regulatory compliance is insufficient; optimizing FRQ through IFRS adoption, accounting digitalization, and the reinforcement of auditing stands as vital strategic tools for improving credit ratings and unlocking external financing for SMEs.*

Key words: *Quality of Financial Reporting (FRQ), Cost of Debt, Bank Guarantees, Cash Flows.*

JEL: M40, G10.

Introduction

In the modern financial market, accounting information has transcended its traditional role as a mere historical record, evolving into a strategic asset within the communication process between entities and capital markets. Today, disclosure quality forms the bedrock upon which investor and creditor trust is established. For a transition economy like that of the Republic of Moldova, where the capital market remains underdeveloped and bank lending represents the primary source of external capital, informational asymmetry continues to pose a major challenge. The structural divergence between National Accounting Standards (NAS) and International Financial Reporting Standards (IFRS) provides a compelling analytical framework for understanding how reporting rigor directly influences the cost of borrowed funds.

The purpose of this study is to investigate, through the lens of specialized literature and recent regulatory developments, whether the adoption of a more complex reporting framework (IFRS) and an enhanced quality of explanatory notes can serve as signals of stability, leading to a reduction in the cost of debt and a relaxation of collateral requirements. In the context of aligning national regulations with the EU *acquis*, recent research highlights the necessity of an integrated debt reporting methodology. As argued by Russu (2025), financial debt can no longer be viewed merely as a certain

liability, but rather as a strategic source whose transparency directly shapes risk predictability. Furthermore, discrepancies between NAS and IFRS regarding the evaluation of borrowing costs and complex hybrid instruments—such as corporate bonds and redeemable shares—can distort performance indicators, directly impacting the cost of attracted capital. Consequently, financial reporting quality (FRQ) emerges as a critical determinant of an economic entity's bargaining power in relations with external creditors.

Basic content

Research Methodology

The present study employs a qualitative methodology based on content analysis and a critical-comparative approach to recent empirical literature, utilizing foundational reference sources. In the first stage, a synthesis of evidence from international literature was conducted to identify the primary channels through which informational transparency influences creditors' decisions. Subsequently, these theoretical models were transposed and adapted to the specific context of the Republic of Moldova. This approach enabled a direct assessment of how financial reporting quality determines the behavior of commercial banks in the Republic of Moldova during the credit granting process.

Literature Review

Within specialized literature, the nexus between informational transparency and external financing mechanisms occupies a central role, demonstrating that corporate financial reporting directly influences investor behavior and the cost of capital. In this regard, current developments reflect an expansion of the reporting scope, migrating beyond the rigid boundaries of classical financial statements toward sustainability, integrated, and ESG paradigms. Rather than substituting financial reporting, these new informational frameworks act as validation factors of its quality, reconfiguring access to external resources through four main channels:

- **Sustainability Reporting (CSR):** acts as a catalyst for reducing overall informational asymmetry. Corporate social responsibility disclosures have ceased to be mere public relations tools, evolving into fundamental pillars for credit risk assessment. An expanded volume and higher quality of reports, backed by independent external assurance, mitigate financing constraints and facilitate access to capital (García-Sánchez et al., 2019).
- **Integrated Reporting (IR):** functions as a direct determinant of the cost of capital. High-quality integrated reporting is empirically associated with a significant decrease in the cost of debt for listed European firms (Raimo et al., 2021). However, a purely quantitative expansion of IR disclosures does not guarantee a reduction in the cost of equity; its actual impact depends on specific external financing needs and the entity's structural credibility (Lailiyah & Permatasari, 2025).
- **ESG Framework (Environmental, Social, and Governance):** represents a cornerstone of investment efficiency, particularly in emerging markets. High-quality ESG disclosures are correlated with lower borrowing costs; as these costs decrease due to robust disclosures, negative phenomena such as corporate under-investment and over-investment are corrected (Kookkaew et al., 2026).
- **Financial Reporting Regimes:** The introduction of a more stringent financial reporting regime drives a generalized expansion of external financing opportunities and an increased volume of investment at the firm level, with adjustments between debt and equity being modulated by the borrowing capacity of the entities (Naranjo et al., 2020).

Table 1. Synthesis of the relationship between reporting type and its effects on external financing

Reporting type	Primary effect on external financing
CSR	Reduces financing constraints, improves access to capital (García-Sánchez et al., 2019)
Integrated Reporting (IR)	Decreases the cost of debt (Raimo et al., 2021)
ESG Reporting	Decreases the cost of debt and improves investment efficiency (Kookkaew et al., 2026)
Strict Reporting Enforcements	Increases the utilization of external financing and investment volume (Naranjo et al., 2020)

Source: Developed by the author based on [2, 4, 5, 6]

While advanced frameworks like ESG and Integrated Reporting represent the global frontier of transparency, for transition economies like the Republic of Moldova, the immediate baseline priority remains the transition from national accounting standards to IFRS.

The accounting regulatory framework: A driver of reporting quality in optimizing access to capital

While the quality of financial information modulates investor decisions at a conceptual level, in practice, this quality is guaranteed by the rigor and evolution of the financial reporting and accounting regulatory framework. From this perspective, Financial Reporting Quality (FRQ) cannot be dissociated from institutional alignment efforts. A primary, essential pillar in consolidating FRQ as a driver for attracting external resources is the ongoing harmonization of national accounting systems with International Financial Reporting Standards (IFRS), European Directives, and International Public Sector Accounting Standards (IPSAS). This global convergence does not merely aim for regulatory compliance, but rather for the structural standardization of fundamental qualitative characteristics—such as relevance, faithful representation, comparability, and timeliness of information (Golochalova & Turcanu, 2020; Lazari & Iavorschi, 2025; Railean, 2022). When an emerging market adopts these unified qualitative attributes, cross-border informational asymmetry is drastically reduced, providing international creditors with a common, trustworthy financial language.

This structural accuracy must be reflected above all in the depth of disclosures presented within the financial statements. Specifically, clarifying and rigorously aligning the content of the explanatory notes with IFRS requirements—particularly in the complex area of financial instruments—represents a critical condition for eliminating the risk of reporting ambiguous or misleading data (Korol & Sokolova, 2019). Detailed explanatory notes function as a protective shield against uncertainty: the more transparent the disclosures regarding financial instruments, the lower the risk margin demanded by financiers. Furthermore, enhancing reporting quality requires the development of detailed sector-specific methodological guidelines, such as those tailored for Public-Private Partnerships (PPPs) or other highly specific economic areas. Centered on transparency, consistency, and the digitalization of reporting processes, these guidelines enable the standardized transmission of data to capital market participants, thereby optimizing the financial screening process (Panus, 2025).

In sectors heavily monitored by investors, such as the insurance industry, promoting non-financial reporting through clear regulations focused on Key Performance Indicators (KPIs) becomes a strategic priority for attracting reinsurance capital and institutional investment (Dolghi, 2023). Ultimately, for reporting standards to be recognized as genuine instruments for guaranteeing FRQ to external investors, the simultaneous reinforcement of corporate governance and monitoring mechanisms is mandatory. The synergistic operation of internal and external auditing, independent audit committees, and active boards of directors forms the supervisory core that ensures true compliance with standards and prevents earnings management. This control infrastructure is vital, especially within financial institutions, where high-

quality reporting restores the confidence of depositors and long-term creditors, solidifying the stability of the entire financial system (Sahi et al., 2022).

The transmission channels of financial reporting quality (FRQ) on access to finance

To gain a profound understanding of how financial reporting quality (FRQ) becomes a fundamental driver of access to external financing, it is essential to delineate its mechanisms through the lens of the microeconomic agency theory. Specifically, FRQ does not act in isolation; rather, it operates through clear channels that mitigate financial transparency deficits, adverse selection, and moral hazard. The mitigation of these market frictions subsequently materializes into tangible contractual advantages for entities, reflected in the efficiency of the initial screening process, the optimization of loan pricing (the reduction of the cost of capital), increased flexibility in collateral requirements, the calibration of restrictive clauses (covenants), and a reduced intensity of post-lending monitoring.

Mitigating credit risk and optimizing transparency. A high level of financial reporting quality implies superior informational transparency, which diminishes the initial uncertainty experienced by external financiers during the analysis phase. When corporate earnings quality is solid, investors and creditors can forecast future cash flows with greater accuracy. Conversely, a reduced level of earnings quality directly amplifies the adverse selection component reflected in transaction costs, prompting market participants to demand an additional risk premium to compensate for information opacity (Bhattacharya et al., 2013). Therefore, mitigating the risk of adverse selection grants transparent entities significantly greater flexibility in issuing equity and, implicitly, drives a faster convergence toward the optimal capital structure, ensuring better stability and long-term financial equilibrium (Biddle et al., 2009; Synn & Williams, 2023). From the perspective of credit institutions, improving the rigor of financial reporting—as demonstrated globally by major structural reforms like the US Sarbanes-Oxley Act (SOX Section 404)—strengthens banks' capacity to conduct significantly more efficient *ex-ante* screening. This optimized screening allows for a sharp differentiation of risks and leads to the construction of loan portfolios with a superior qualitative profile, reducing the incidence of non-performing loans (Gallimberti, 2020). Concurrently, adopting a conservative accounting approach and ensuring the timely recognition of economic losses acts as a signal of credibility in capital markets, reducing the overall cost of debt (Chen & Zhu, 2013; Wittenberg-Moerman, 2008).

Once the initial capital allocation phase is completed, the protective role of financial reporting quality shifts to the post-contractual phase, acting as an instrument for controlling moral hazard. In credit markets, the risk that management or majority shareholders might adopt opportunistic behavior to the detriment of creditors (underinvestment, asset substitution, or obtaining unjustified benefits) is closely linked to the opacity of financial reports. A high FRQ severely restricts this scope for opportunistic manipulation by providing prompt and verifiable accounting signals. As a result, external creditors can significantly reduce their expenditures on the direct monitoring of debtors.

This informational efficiency brings about a profound restructuring of contractual clauses. Instead of resorting to rigid collateral requirements (heavy physical guarantees and asset encumbrances), financiers become willing to structure flexible contracts based on financial covenants anchored directly in high-quality accounting indicators. When the financial reporting system instills confidence, performance indicators become predictive, allowing the activation of automated protective mechanisms only in the event of an actual deterioration in performance.

In conclusion, qualitative financial reporting functions as a genuine institutional "antidote" to information asymmetry, adverse selection, and moral hazard. It reduces the fundamental cost of information processing, streamlines bank screening and monitoring, and enables the transition from lending based exclusively on patrimonial guarantees to financing based on performance and the quality of reported financial cash flows.

Configuring the relationship between Financial Reporting Quality and creditor behavior in the Republic of Moldova: The "Collateral vs. Cash Flows" Dilemma

In the Republic of Moldova, informational gaps manifest directly in the relationship between entities and credit analysts within commercial banks. Credit risk management has historically relied on an asset-based approach, governed by the requirement of massive real estate collateral (Băncilă & Popovici, 2022). This rigid institutional preference represents a direct response to the formalism and poor quality of information reported under National Accounting Standards (NAS). Under the NAS regime, explanatory notes are frequently minimalist and opaque. Faced with this lack of transparency, commercial banks compensate for adverse selection risks by imposing stringent pledge conditions. Empirical studies conducted on the Moldovan market confirm that the lending sector remains heavily anchored in this paradigm, where high collateral requirements constitute the main barrier to accessing bank resources, with over 39% of managers assessing these requirements as extremely high, while the aggregate indicator records a negative mean score (mean = 2.14; Kea = -0.86) (Ianioglo, 2023).

This barrier affects local market companies differently, depending on their size and specific field of activity. While large corporations and entities in highly visible sectors (such as the IT sector) access capital relatively easily, micro-enterprises, HoReCa companies, and rural businesses feel the collateral constraints most acutely (Ianioglo, 2023). The situation is structurally compounded by imperfections in the national regulatory framework regarding pledges and the absence of liquid secondary markets for the rapid liquidation of pledged assets in the event of default. This aspect inflates transaction costs for banks and, consequently, increases the price of credit for borrowers (Băncilă & Popovici, 2022). Even state-backed interventions, such as the government guarantee schemes during the pandemic crisis, failed to resolve the core issue; empirical evidence suggests that such mechanisms tend merely to substitute unsecured loans with secured ones, without inducing a net expansion in the total volume of financing (Altavilla et al., 2025).

Within emerging economies, the impact of financial transparency deficits on credit allocation manifests as a structural trade-off between asset-based lending and performance-driven assessment. Evaluation based on cash flows and dynamic profitability indicators (specific to investment projects) is widely recognized as superior for efficient resource allocation. However, its feasibility is strictly conditional upon the existence of transparent, faithful, and audited financial statements—namely, a high Financial Reporting Quality (FRQ) (Onikiienko et al., 2021; Jovičić & Pešić, 2024).

This dynamic changes radically with the transition to International Financial Reporting Standards (IFRS), a process that acts as a catalyst for enhancing reporting quality. The IFRS framework compels entities to shift toward reporting based on economic substance and forward-looking estimates, mandating a transparent disclosure of cash flows and financial risks (Jovičić & Pešić, 2024; Onikiienko et al., 2021). To visualize how the level of reporting quality reconfigures the bank evaluation process, this structural relationship is synthesized in Figure 1.

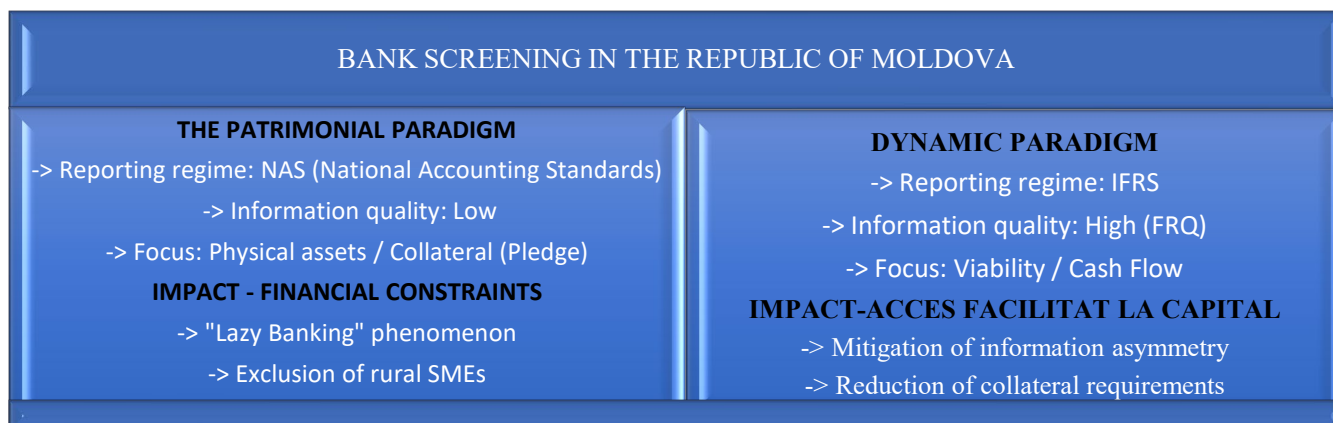


Figure 1. The structural matrix of bank screening in the Republic of Moldova based on FRQ

Source: Developed based on the research findings documented by Ianioglo (2023), Onikiienko et al. (2021), Băncilă & Popovici (2022), and Jovičić & Pešić (2024).

The structural matrix presented in Figure 1 clearly highlights that optimizing Financial Reporting Quality (FRQ) becomes the fundamental pillar upon which the transition from historical, asset-based lending to performance-driven financing can be constructed. As long as financial reporting under the national framework based on NAS generates informational opacity, commercial banks in the Republic of Moldova will exhibit heightened risk aversion, discounting economic viability in favor of physical collateral.

Consequently, for the Republic of Moldova, fostering IFRS adoption, enhancing disclosures within the explanatory notes, and conducting external audits of financial statements represent the only mechanisms capable of delivering sufficiently reliable financial statements. Only by achieving this level of transparency will banking institutions be enabled to migrate from the static analysis of pledges toward the dynamic evaluation of performance and actual cash flows generated by economic entities.

Conclusions

The present research demonstrates that enhancing Financial Reporting Quality (FRQ) extends beyond mere regulatory compliance, serving as a strategic driver in optimizing access to external financial resources. Internationally, informational transparency—underpinned by the implementation of IFRS frameworks, integrated reporting, and ESG indicators—ensures a comprehensive and verifiable flow of both financial and non-financial data to creditors. This mechanism mitigates initial lender uncertainty by providing a faithful representation of repayment capacity, thereby directly reducing credit risk and driving a substantial decrease in the cost of debt. In the Republic of Moldova, however, a structural deadlock is observed. The national banking system remains anchored in an asset-based lending paradigm, dominated by the requirement of massive real estate collateral, which restricts SME financing. This rigid institutional preference of banks is directly fueled by the quality of financial statements prepared under NAS. The content of the explanatory notes accompanying these financial statements hinders the application of modern screening methods based on economic performance and cash flow analysis. Consequently, optimizing FRQ through the transition to IFRS represents the fundamental pillar capable of reconfiguring creditor behavior, offering superior predictability over liquidity and implicitly allowing for a relaxation of collateral requirements. Building upon the conclusions of this study and the current limitations of the specialized literature within the national framework, subsequent investigations should focus on the following priority directions:

- *Direct quantitative empirical analyses*: evaluating, through econometric models, the direct impact of the transition from NAS to IFRS on bank interest margins (credit spreads) and on the volume of physical collateral required from entities in the Republic of Moldova. Such an approach would allow for the exact quantification of the financial benefits generated by the enhancement of financial reporting quality.
- *The role of qualitative information in financial assessment*: studying the extent to which non-financial variables—such as management reputation, corporate governance, and relationship history with the bank—can compensate for the lack of physical collateral assets. This research direction is vital for facilitating the financing of early-stage entities (start-ups) and companies in innovative sectors, such as services and information technology (IT).

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DETERMINANTS OF SUSTAINABILITY REPORTING: THE ROLE OF COMPANY SIZE-A BIBLIOMETRIC ANALYSIS

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Abstract: *Against the backdrop of increasingly stringent European regulation on sustainability, non-financial reporting has become a critical tool for companies and for corporate transparency. This study examines the role of company size as a determinant of the quality of ESG reporting and examines the interdependencies between financial performance indicators and transparency. This aim is to identify the intellectual structure, chronological development, and main thematic group that define this field within the Web of Science database.*

This study adopts a bibliometric analysis of a composite sample of primary research articles. The analysis was conducted using keywords co-occurrence and network analysis techniques with the help of Vosviewer. The data was segmented to highlight the distribution across Web of Science and the trends in the number of publications from 2020 to 2026. We conducted a systematic search of the Web of Science database using the following keywords: "sustainability reporting," "size," and "firm size", resulting in 469 articles.

As a result, the temporal analysis indicates an exponential increase in interest. The bibliometric mapping also reveals several thematic clusters focused on ESG disclosure, corporate governance, transparency, and firm characteristics, highlighting the increasing importance of company size as a determinant of sustainability reporting practices. This article provided an overview of the intellectual structure of literature on sustainability reporting, highlighting the critical role that firm size plays in ensuring the quality and transparency of non-financial information.

Keywords: *ESG disclosure, Firm size, corporate governance, sustainability reporting*

JEL: M14, M41, Q56

Introduction

The Brundtland definition states, "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Most citations of the definition focus on the first sentence of the Brundtland definition (above), with its emphasis on the concept of intergenerational equity. (Gallo & Christensen, 2011)

Stakeholders' demand for companies to provide social, economic, and environmental reports is increasingly becoming an important requirement for companies. (Ikpor et al., 2022)

Sustainability reporting according to the World Business Council for Sustainable Development (WBCSB) is defined as the public reports by companies to provide internal and external stakeholders with a picture of corporate position on social economic and environmental activities.

This study explores the intersection between firm size and transparency ESG, a field that, according to our preliminary analysis, is structured around three fundamentals pillars: the key pillar, governance and profitability, the operational, the quality of disclosure, and regulatory pillar.

Content

Theoretical background

The literature suggests that the motivation for sustainability reporting is for companies to communicate their commitments to sustainable development as well as to describe the results of their actions in social, economic and environmental dimensions.

Previous studies on sustainability reporting have revealed that certain company characteristics influence the extent and nature of sustainability reporting. (Ikpor et al., 2022)

The new European Standards (ESRS) aim to eliminate the disparities between large and small companies. ESRS Standards, introduced by the CSRD Directive, were created to establish a common language:

- an old problem: in the past, large companies used to pick their own metrics, small businesses were not reporting anything, creating a data gap.

- The ESRS solution: the new standards required large companies to report comparable data and verifiable. To help small businesses (SMEs), the EU introduced a simplified version, reducing the administrative burden while maintaining rigor. The size of the firm is no longer an excuse for a lack of transparency, but a criterion for proportionality of reporting.

Research methodology

A bibliometric analysis covering several years has the advantage of highlighting how the academic landscape is evolving, and therefore scientific interests in relation to a particular topic.

Bibliometric research analyses a large number of scientific publications using statistical tools to identify certain trends and citations associated with a topic of interest, broken down into categories such as years, authors, journals, countries, methods, etc.

The data for this research was taken and collected from Web of Science, an online data platform containing information on scientific journals, scientific papers, books, and more.

To begin with, I expanded the search, yielding 1,720 results for the period 2020-2026. I should note that for the year 2026, using the following thematic search: the data is incomplete, as the search was conducted at the end of April.

Thematic search is illustrated in the following figure:

The screenshot displays the 'FIELD SEARCH' tab of the Web of Science search interface. It features a search bar with the query 'sustainability reporting' and a dropdown menu set to 'Topic'. Below this, there is a second search bar with the query 'size' and a dropdown menu also set to 'Topic'. A minus sign icon is visible between the two search bars, indicating a Boolean 'AND' search. At the bottom, there are buttons for '+ Add row', '+ Add date range', 'x Clear', and a magnifying glass icon followed by 'Search'.

Figure 1 First Thematic search

Source: Web of Science

Field categories:



Figure 2 Fields of publications collected from Web Of Science

Source: Web of Science

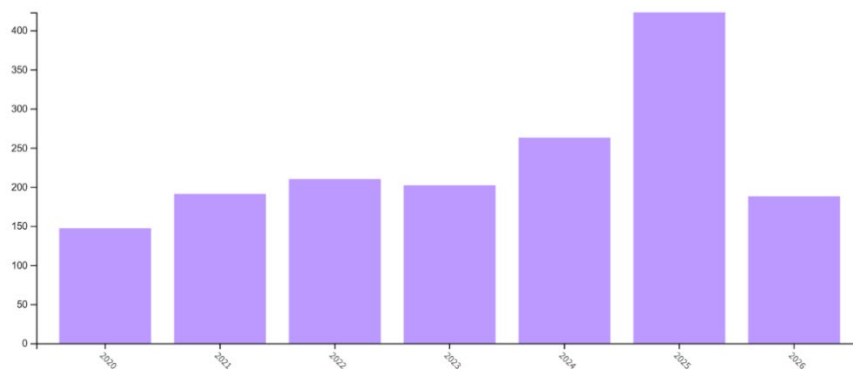


Figure 3 Evolution of Publications for the Years Analyzed

Source: Web of Science

As shown in the images above, we can see a high level of interest in this search topic, which has grown over time; by 2025, the graph will show a significant increase compared to previous years. Initially, a search of the Web of Science database yielded raw sample of 1720 articles. The map looks like:

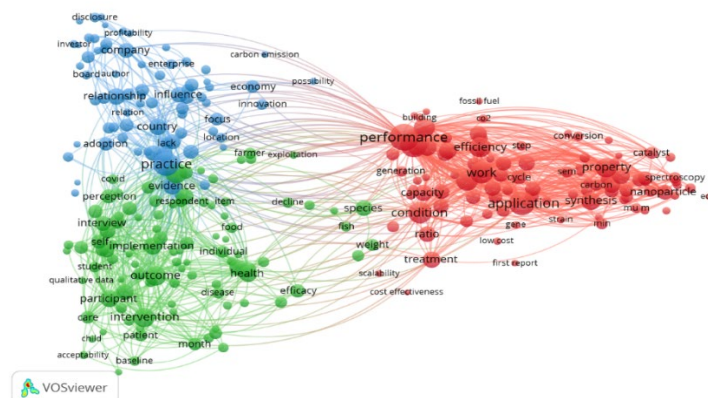


Figure 4 VOSviewer network initially visualization map

Source: own processing in VOSviewer

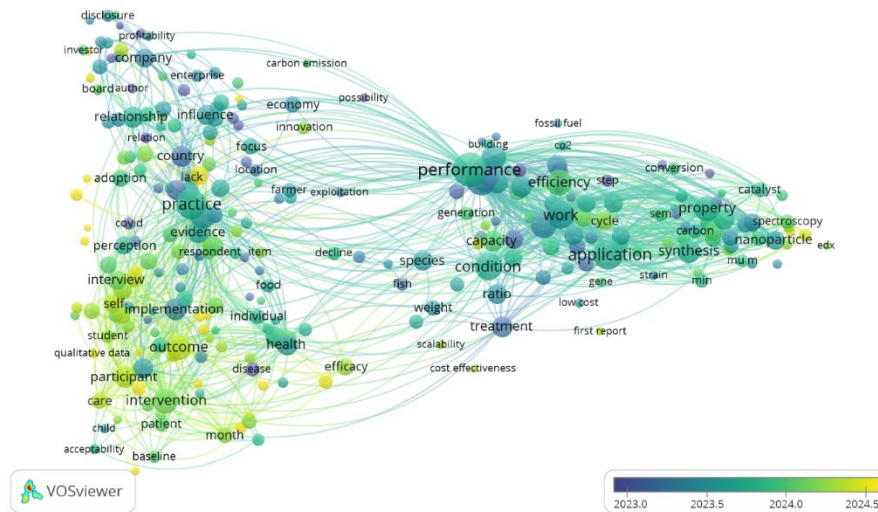


Figure 5 VOSviewer network initially overlay map

Source: own processing in VOSviewer

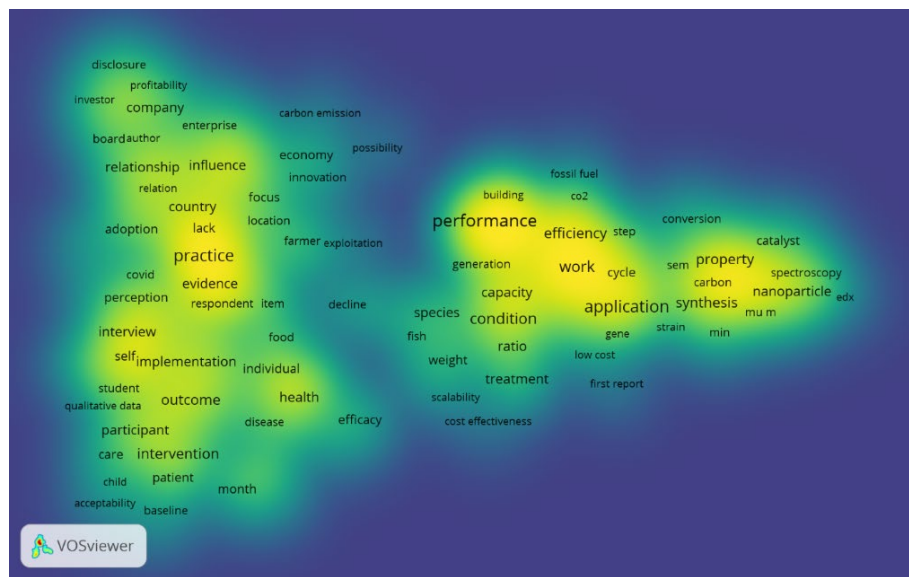


Figure 6 VOSviewer network initially density map

Source: own processing in VOSviewer

Preliminary analysis of the co-occurrence network of keywords reveals significant thematic dispersion. To ensure the academic relevance and applicability of the results in the field of corporate sustainability, the criteria were refined.

Through applying filter-specifics to the Business, Economics, and Management categories, the sample map was narrowed down to 469 items.

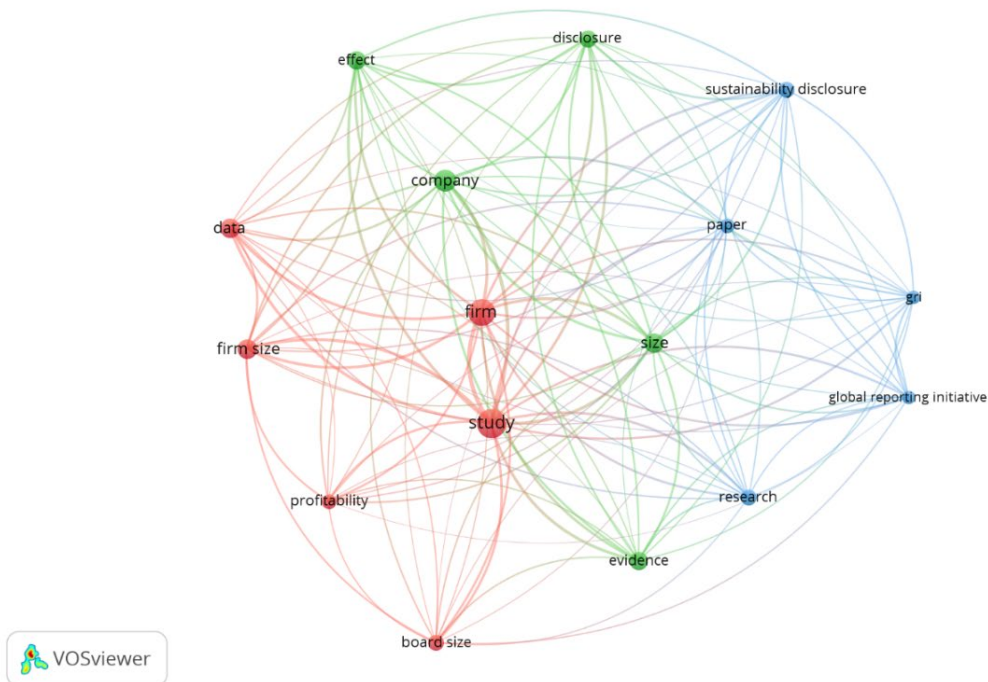


Figure 7 VOSviewer network final visualization map

Source: own processing in VOSviewer

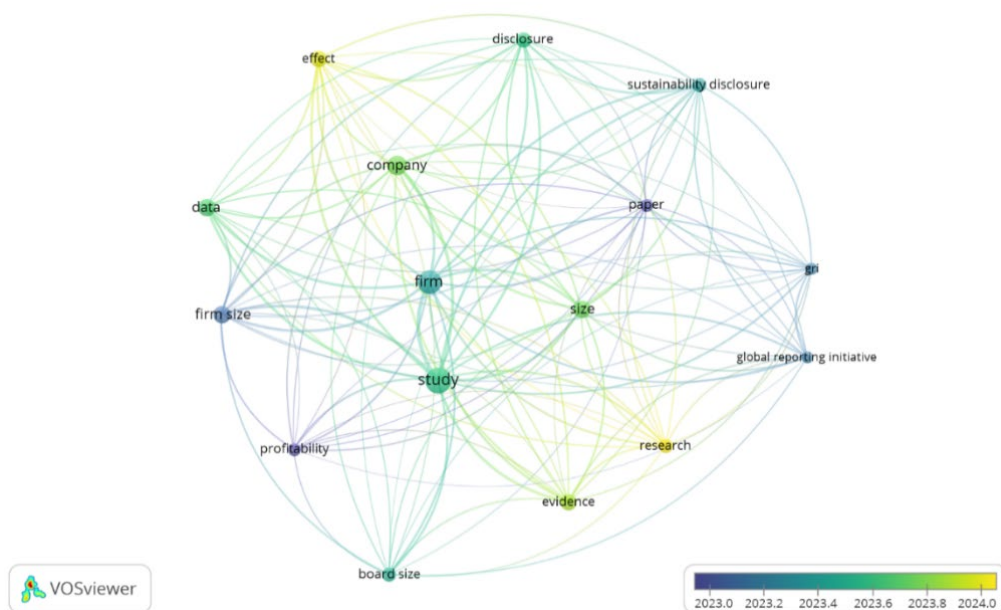


Figure 8 VOSviewer network final overlay map

Source: own processing in VOSviewer

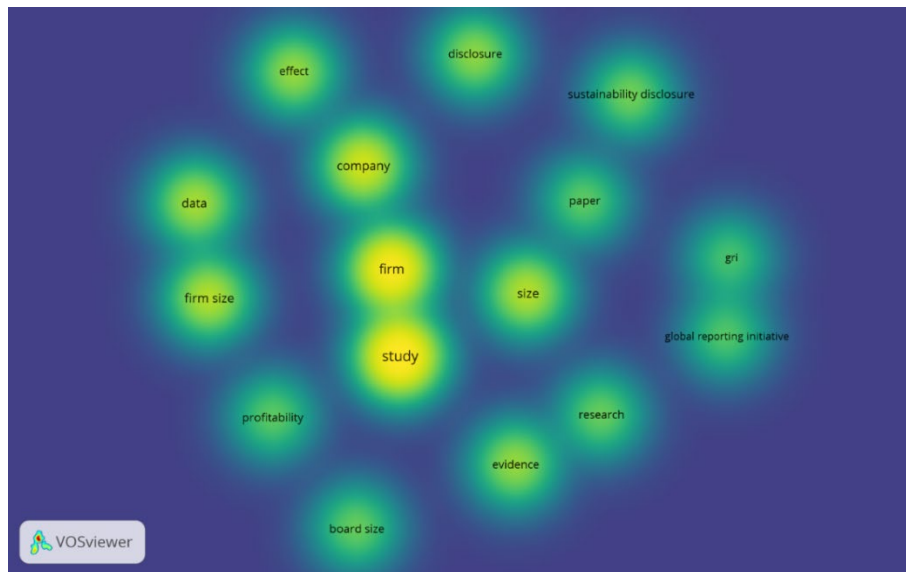


Figure 3.8 VOSviewer network final density map

Source: own processing in VOSviewer

This second stage presents a coherent intellectual framework, centered exclusively on the interplay between governance, transparency, and firm characteristics, by filtering out irrelevant information. This represents the core of the research. We can see the central nodes are firm, sustainability disclosure, gray, and profitability. This map answer of my research questions.

Results and discussions

The map shows the co-occurrence of terms extracted from the articles. They grouped into three thematic clusters:

Table 4.1 Thematic clusters

Cluster(VOSviewer)	Key Concepts	Focus in Literature Review	Hypotheses suggested by the Literature
Red(Determinant)	Firm Size, Profitability, Board Size	Financial Pillar: anlysis of the impact of internal structure and financial resources.	Firm with large boards and high profitability tends to have more transparency reporting.
Green(Processual)	Disclosure, Company, Effect	Operational Pillar: examination of empirical evidence regarding the quality of data published by firms.	Firm size acts as a moderator between sustainability actions and market perception.
Blue(Normative)	GRI, Sustainability disclosure, Research	Standardization pillar: The role of international guidelines in standardization reporting.	Adopting GRI standards reduces information asymmetry, particulary amoung large firms.

Source: own processing based on VOSviewer data (2026)

Analysis of thematic search

The *visualization map* confirms that the structure of the field is divided into three clusters, and the idea of how firm size dictates the sustainability agenda.

The financial and governance determinants- Red Cluster- show a strong correlation between board size, firm size, and profitability. The data suggests that transparency is not just a choice but also a function of available resources. Large firms must have complex reporting frameworks.

The operational process and market perception- Green Cluster- is centered on disclosure and effects, on the idea: why firms report, how they do it, and what the impact is. Firm size, we can say that, is like a moderator because an action taken by a large company has a different effect compared with the same action taken by a small company.

The normative framework and standardization- Blue Cluster- is anchored by the Global Reporting Initiative (GRI) and sustainability disclosure. This cluster is the legal and ethical anchor of the research. In the context of CSRD and ESRS, this cluster presents the transition from voluntary to mandatory reporting.

Evolution of trends (2020-2026)

In addition to the thematic clusters, the chronological analysis presents a pivot point around 2023:

- Pre-2023: focus on the correlation between size and the existence of a report.
- Post-2023: focus on quality and digitalization of reports, as well as the concept of Double Materiality, large firms reporting how climate change affects their long-term financial valuation.

Conclusions

This article provided an overview of the intellectual structure of literature on sustainability reporting, highlighting the critical role that firm size plays in ensuring the quality and transparency of non-financial information.

Theoretical conclusion

The bibliometric analysis conducted using VOSviewer showed that the field is structured around three clusters: financial and governance, operational, and regulatory and standardization.

- ✓ Size determinants: The result confirms the hypothesis that companies, large companies, which have greater financial resources, tend to have more mature, company size is no longer an indicator of the volume, but a criterion of proportionality in the context of the new ESRS standards.
- ✓ Trend evolution: A time-series analysis presents a paradigm shift after 2023, according to a report, the current period 2024-2026 places an emphasis on the quality of reporting, digitalization.

Limitations and future research directions

The study offers valuable insights, but it has certain limitations. First of all, the data of 2026 was incomplete, covering only the first four months of the year. In the second part of this study the analysis was limited to the Web of Science database.

Future research should include:

- A comparative analysis of reporting quality in the EU versus regions with stricter regulation;
- Investigating the impact of artificial intelligence on the automation of ESG, with data for small and medium-sized businesses;

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CONTRACTUAL SERVICE MARGIN UNDER IFRS 17: FROM INITIAL RECOGNITION TO PROFIT RECOGNITION

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Abstract: *The purpose of this paper is to analyze the role of Contractual Service Margin (CSM) within IFRS 17 and its implications for the quality of financial reporting in the insurance industry. The study adopts a conceptual approach, supported by illustrative examples, to highlight the mechanisms for recognizing and measuring CSM. The results show that the introduction of CSM eliminates the immediate recognition of profits and requires their distribution over the life of the contracts, contributing to a better correlation between revenues and services provided. Thus, the relevance and faithful representation of financial information are improved. The paper highlights the role of key components, such as fulfillment cash flows, risk adjustment and coverage units, as well as the particularities of the treatment of reinsurance contracts. At the same time, challenges related to complexity, actuarial estimates and implementation are identified.*

Keywords: *Contractual Service Margin (CSM), Insurance accounting, Profit recognition, IFRS 17, Financial reporting quality*

JEL: M41

Introduction

The adoption of the international standard IFRS 17 marked one of the most important recent transformations in insurance contract accounting, with the main objective of increasing the transparency and comparability of financial reporting at an international level. The standard, issued by the International Accounting Standards Board in 2017 and becoming applicable as of 1 January 2023, was designed to replace the IFRS 4 standard, considered insufficient from the perspective of coherence and comparability of information provided to users of financial statements (IASB, 2017; KPMG, 2020).

One of the most significant changes introduced by IFRS 17 is the way in which profit from insurance contracts is recognized. Unlike the previous approach, the new standard proposes a model based on the updated measurement of obligations and the gradual recognition of profit over the period of providing insurance services. In this context, the concept of Contractual Service Margin (CSM) becomes a central element of the accounting model, reflecting the profit not recorded at the initial moment and subsequently recognized during the contractual period (Bauer et al., 2018; Deloitte, 2021). The importance of CSM derives not only from its technical role within the valuation model, but also from its implications on the reported financial performance. Through its mechanism of "deferring" profit, CSM contributes to smoothing financial results over time, reducing their volatility. However, the literature highlights that this approach introduces a significant degree of reliance on estimates and professional judgments, which may affect the comparability between entities and the relevance of information to users (Morales & Walker, 2021; EY, 2022).

Despite the numerous studies dedicated to the implementation of IFRS 17, a large part of the existing research focuses on the technical and actuarial aspects of the standard, paying less attention to the conceptual implications of essential components such as the CSM. Thus, there is a need for an

analysis that goes beyond the strictly methodological dimension and highlights the role of this mechanism in the broader context of the quality of financial reporting. In this context, the purpose of this article is to analyze, from a conceptual perspective, the role of the Contractual Service Margin within IFRS 17 and its implications for the financial reporting of insurance companies. The approach is based on a synthesis of the specialized literature, complemented by illustrative numerical examples, and aims to highlight both the mechanisms for determining and recognizing the CSM, and to analyze the benefits associated with this concept, respectively identifying the limitations and challenges it entails in practice.

The conceptual framework of IFRS 17

IFRS 17 introduces a unified conceptual framework for the recognition, measurement and presentation of insurance contracts, with the objective of providing relevant and comparable information to users of financial statements. In contrast to the permissive approach of IFRS 4, the new standard proposes a coherent model based on economic principles, which more faithfully reflects the obligations assumed by insurance entities (IASB, 2017). At the heart of IFRS 17 is the so-called general valuation model, also known as the "building block approach" (BBA). This model involves the valuation of insurance contracts by combining four main components, which reflect both the financial dimension and the uncertainty associated with future cash flows (IFRS Foundation, 2018; PwC, 2021).

The first component is represented by future cash flows (fulfilment cash flows), which include updated estimates of cash inflows and outflows generated by insurance contracts. These estimates must be based on current information, reflect all possible scenarios and be adjusted for probability, which gives the model a prospective nature (Deloitte, 2021). The second component is the discount rate, used to reflect the time value of money and the characteristics of cash flows. IFRS 17 does not impose a rigid method of determining it, allowing entities to use approaches adapted to the specifics of the portfolio, which introduces a certain degree of flexibility, but also of professional judgment (KPMG, 2020). The third component is the risk adjustment, which reflects the compensation that the entity requires for assuming the uncertainty associated with non-financial risks. This component is essential to highlight differences in risk perception between entities and to provide a more complete picture of the obligations assumed (EY, 2022). Finally, the fourth component, Contractual Service Margin (CSM), represents the profit not recorded at the initial moment and which is recognized during the contract coverage period. The role of this component is to prevent the immediate recognition of profit at the initial moment and to ensure its systematic distribution according to the services provided (Bauer et al., 2018).

By integrating these four elements, IFRS 17 creates a valuation model that more closely reflects the economic reality of insurance contracts than the previous standard. However, this approach involves a high level of complexity and reliance on estimates, which can create challenges in implementation and affect comparability across entities, especially in the context of using different assumptions (Morales & Walker, 2021).

The concept of Contractual Service Margin (CSM)

One of the most innovative and discussed elements introduced by IFRS 17 is the Contractual Service Margin (CSM), which reflects the profit not recorded at the initial recognition of an insurance contract. By introducing this concept, the standard fundamentally changes the way in which the financial performance of insurance companies is reflected in the financial statements, shifting the emphasis from the immediate recognition of profit to an approach based on the provision of services over time (IASB, 2017).

Definition and role

CSM represents the amount of future profit that an entity expects to obtain from an insurance contract and that is not recognized at the initial moment. According to IFRS 17, if the discounted value of future cash flows leads to a positive result (i.e. an anticipated profit), this profit is not recorded

immediately, but is included in CSM and recognized gradually over the life of the contract (IFRS Foundation, 2018; Deloitte, 2021). The main role of CSM is therefore to ensure a correlation between revenue recognition and the provision of insurance services, thus avoiding the reporting of unrealized gains at the initial moment. This approach contributes to a more faithful representation of the entity's economic performance (PwC, 2021).

The operating mechanism

From an operational point of view, the CSM is determined at the initial recognition of the contract as the difference between the present value of future cash flows and the other components of the valuation model. Subsequently, it is adjusted according to changes in estimates related to future services and is recognized in the profit and loss account as the insurance services are provided (KPMG, 2020). The recognition of the CSM occurs systematically, based on a model that reflects the transfer of services to the insured. Thus, as the contractual obligations are fulfilled, a part of the CSM is "released" and recorded as income, contributing to the financial result of the period (EY, 2022).

The importance of CSM within IFRS 17

The importance of CSM is not only technical, but also conceptual. Through this mechanism, IFRS 17 introduces a more prudent and realistic approach to profit recognition, reducing the risk of overstating financial performance at the inception of the contract. At the same time, CSM contributes to stabilizing financial results over time, which can facilitate the analysis of performance by investors and other users of financial information (Bauer et al., 2018).

However, the literature highlights that this mechanism involves a high level of complexity and reliance on estimates, especially regarding assumptions regarding future cash flows and services. This feature can influence comparability between entities and can introduce significant variations in financial reporting, depending on the professional judgments applied (Morales & Walker, 2021).

Contractual Service Margin – determination and evaluation mechanisms

Understanding the impact of Contractual Service Margin (CSM) on financial reporting inevitably requires an analysis of how it is determined. Although, conceptually, CSM represents the unearned profit related to insurance contracts, in practice, its calculation involves a series of complex steps, based on estimates and professional judgment.

The process begins with estimating the future cash flows associated with the insurance contract. These include premiums earned, expected claims, administrative expenses and acquisition costs. According to the requirements of IFRS 17, these estimates must be explicit, unbiased and probability-weighted, reflecting management's best estimates of the future evolution of the contract. Subsequently, the cash flows are discounted to their present value by applying a discount rate that reflects both the time value of money and the specific characteristics of the liabilities in the insurance contracts. This step is essential, as it directly influences the size of the obligations recognized in the balance sheet. A distinctive element of the IFRS 17 model is the inclusion of the risk adjustment, which represents the compensation required by the insurer for the uncertainty associated with the future cash flows. This adjustment reflects the entity's risk aversion and helps to differentiate the economic value of the obligations from a simple statistical estimate.

The CSM is determined as the difference between the cash flows related to the fulfillment of obligations and the initial value of the contractual liability, with the role of eliminating the immediate recognition of profit. Basically, it functions as a mechanism to "block" the initial gain, which is subsequently recognized in the profit and loss account as the insurance services are provided. An essential aspect, often emphasized in the specialized literature, is the dynamic nature of the CSM. At each reporting date, it must be reassessed to reflect changes in the initial estimates, being adjusted according to the new information available. At the same time, the CSM is gradually reduced as the coverage services are provided, and in situations where the contracts become onerous, it can be significantly reduced or even eliminated.

This sequence of steps highlights that the CSM is not a static indicator, but the result of a continuous process of estimation and recalibration. From this perspective, the complexity of its calculation explains both the high relevance of the information provided and the challenges related to comparability and transparency in financial reporting.

Determining the Contractual Service Margin at initial recognition

To understand the role of Contractual Service Margin (CSM) under IFRS 17, it is essential to analyze how it is determined at the time of initial recognition of insurance contracts. Unlike traditional economic approaches, in which the total expected result of a contract is immediately reflected in the financial position, IFRS 17 introduces a different logic, based on prudence and on correlating the recognition of profit with the provision of services. In an economic framework, similar to that used in solvency regulations, profitable contracts can generate, at the initial moment, an economic asset, reflecting the discounted value of future earnings. Symmetrically, loss-generating contracts lead to the immediate recognition of a liability. This approach essentially involves the anticipated capitalization of future performance.

In contrast, IFRS 17 is based on two fundamental principles, which introduce a deliberate asymmetry in the recognition of profit and loss (International Accounting Standards Board, 2017). The first principle stipulates that the estimated profits related to profitable contracts should not be recognized immediately, but distributed systematically over the life of the contract. This requirement is implemented through the CSM, which represents the unearned profit and is gradually recognized in the profit and loss account, as the insurance services are provided. The second principle requires the immediate treatment of losses. Thus, in the case of onerous contracts, the estimated loss is recognized in full at the initial moment, without the possibility of deferring it. As a result, the existence of a negative CSM is not allowed, it being limited to the value of zero in such situations (IFRS Foundation, 2018). Therefore, the CSM becomes the central mechanism that operationalizes this asymmetry: profit is deferred and recognized progressively, while losses are recognized immediately. This approach reflects a prudent orientation of the standard and aims to avoid overvaluing financial performance at the time of contract initiation.

The determination of the CSM at initial recognition is based on the calculation of the cash flows related to the fulfillment of obligations (fulfilment cash flows), which include the estimation of future flows, their discounting and the adjustment for risk. If these flows indicate a gain (negative value of the liability), the difference is recognized in the form of CSM, thus eliminating the possibility of recognizing a "day-one gain". To illustrate this mechanism, Table 1 presents a simplified example of determining the CSM for a group of profitable contracts. In this case, the result of the calculation of the cash flows leads to a favorable position for the insurer, but this gain is not recognized immediately, being fully included in the CSM. Thus, the profit related to the contract is deferred and will be recognized gradually, depending on the services provided.

Table 1. Determination of CSM at initial recognition – profitable contracts

Elements	Value	Explanations
(a) PV of cash inflows	(1,200)	The negative sign indicates cash inflows.
(b) PV of cash outflows	920	Outputs related to compensation and expenses
(c) Risk adjustment	60	Compensation for uncertainty
(d) Fulfilment Cash Flows (a + b + c)	(1,200) + 920 + 60 = (220)	Favorable position for the insurer
(e) CSM = max(-d, 0)	220	Eliminates initial gain

Source: Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

The results indicate that the cash flows related to the fulfillment of obligations record a negative value (–220), which reflects the existence of an anticipated profit. Consequently, a positive CSM of the same magnitude is constituted, which is not recognized immediately, but deferred and distributed over the duration of the contract.

Similarly, Table 2 highlights the situation of onerous contracts, where the CSM is zero and the loss is fully recognized at initial recognition. This difference in treatment highlights the asymmetric nature of IFRS 17 and the relevance of the CSM in ensuring prudent and consistent reporting.

Table 2. Determination of CSM at initial recognition – onerous contracts

Elements	Value	Explanations
(a) PV of cash inflows	(700)	Estimated premiums
(b) PV of cash outflows	880	Compensation and expenses
(c) Risk adjustment	90	Associated uncertainty
(d) Fulfillment Cash Flows (a + b + c)	(700) + 880 + 90 = 270	Unfavorable position
(e) CSM = max(–d, 0)	0	CSM is not recognized.
(f) Loss recognized immediately	270	Recognized in P&L

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

In this example, the cash flows indicate an estimated loss of 270, which is recognized in full at the initial date. Under IFRS 17 principles, deferral of this loss through the CSM is not permitted, highlighting the asymmetric nature of the accounting treatment.

The literature highlights the importance of this mechanism in improving profit recognition discipline and reducing the risk of opportunistic reporting (KPMG, 2020; Deloitte, 2021). At the same time, recent studies highlight that this approach contributes to a better alignment between accounting performance and the actual provision of insurance services, although it may introduce challenges related to the interpretation of financial results (Daniel Bauer et al., 2018).

Determining the Contractual Service Margin at subsequent valuation

After initial recognition, the Contractual Service Margin (CSM) does not remain a static value, but evolves depending on changes in estimates and economic conditions. The insurance business is characterized by uncertainty, and differences between actual experience and initial assumptions, as well as revisions to future cash flows, require a continuous update of the CSM. According to the International Accounting Standards Board (2017), these adjustments are essential to faithfully reflect the obligations related to insurance contracts. Under IFRS 17, changes affecting future services are treated separately, being recognized in the CSM and not directly in the profit and loss account. This approach contributes to a more uniform distribution of financial results over time and a more realistic representation of the economic performance of insurance contracts (IFRS Foundation, 2018). This mechanism is reflected in the following principle:

Principle 3: The CSM should be adjusted for all changes in estimates that relate to future services.

Thus, any update of actuarial assumptions that influence future cash flows will have a direct impact on the CSM. For example, a favorable revision of mortality or claims rates causes an increase in the CSM, while unfavorable changes, such as increased lapse rates or costs, lead to its decrease (Deloitte, 2021). In addition, the effect of the time value of money is also applied to the CSM, through the process of interest accretion, which leads to its value being periodically updated (KPMG, 2020). Table 3 presents an example of a favorable adjustment, in which the update of assumptions leads to an increase in the margin.

Table 3. CSM adjustment following favorable changes in estimates

Elements	Value	Explanations
(a) CSM at the beginning of the period	120	Initial balance
(b) Interest accretion (5%)	6	The effect of value over time
(c) Changes related to future services	35	Favorable review
(d) Adjusted CSM	120 + 6 + 35 = 161	SCM growth

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

It is observed that an initial CSM of 120 is increased by the effect of interest (+6) and favorable changes (+25), reaching a value of 161. This evolution reflects the improvement in estimates regarding future services and the increase in unearned profit.

The improvement in estimates leads to an increase in the CSM, which reflects an increase in unearned profit, which will be gradually recognized in future periods. However, the standard also introduces an important limitation, designed to maintain prudence in financial reporting. Thus, when unfavorable changes exceed the value of the CSM, a negative balance is not allowed. This rule is reflected in the following principle:

Principle 4: The CSM cannot become negative; if adverse changes exceed its value, the difference must be recognized immediately as a loss.

This approach is consistent with the requirements for the recognition of onerous contracts and is explicitly highlighted in the standard (International Accounting Standards Board, 2017). Table 4 illustrates this mechanism.

Table 4. Elimination of CSM and recognition of loss

Elements	Value	Explanations
(a) CSM at the beginning of the period	120	Initial balance
(b) Interest accretion (5%)	6	$120 \times 5\%$
(c) Changes related to future services	(170)	Unfavorable review
(d) Adjusted CSM	$\max(120 + 6 - 170, 0) = 0$	CSM limited to zero
(e) Loss component	44	Immediately recognized

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

In the analyzed situation, the unfavorable changes (–170) exceed the cumulative value of the CSM and interest (126), which leads to the reduction of the CSM to zero and the recognition of an additional loss of 44 in the profit and loss account.

Contractual Service Margin for reinsurance contracts held

The principles applicable to Contractual Service Margin (CSM) in the case of direct insurance contracts are, in general, also applicable to reinsurance contracts. However, the distinct economic nature of reinsurance requires certain adaptations under IFRS 17, in particular with regard to the way in which the costs and benefits related to these contracts are recognized.

Unlike issued insurance contracts, where the CSM reflects unearned profit and cannot be negative, this limitation is no longer applicable to held reinsurance contracts. This difference stems from the fact that reinsurance is not a direct source of profit, but a risk transfer instrument that can generate both benefits and costs for the insurer (International Accounting Standards Board, 2017). In this context, the standard introduces the following principle:

Principle 5: Estimated costs or gains related to reinsurance contracts are not recognized immediately, but are allocated over the term of the contract.

This approach implies that neither the gains nor the costs related to reinsurance are fully recognized at the initial moment. Instead, they are included in the CSM and gradually recognized in the profit and loss account as the reinsurance services are received. Thus, the CSM related to reinsurance becomes a mechanism for distributing over time the economic effects associated with these contracts (Deloitte, 2021). To highlight the application of this principle, Table 5 illustrates the determination of the CSM at initial recognition for a group of reinsurance contracts held.

Table 5. Determination of CSM for reinsurance contracts at initial recognition

Elements	Value	Explanations
(a) PV of reinsurance premiums payable	750	Cash outflows
(b) PV of recoverable damages	(620)	Cash inflows
(c) Risk adjustment ceded	(30)	Risk reduction
(d) Fulfillment Cash Flows	$750 - 620 - 30 = 100$	Net cost of reinsurance
(e) CSM Reinsurance	(100)	Deferred cost over time

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

The results indicate a net reinsurance cost of 100, determined by the difference between the premiums payable (750) and the cash flows recoverable (620), adjusted for the risk ceded (30). In accordance with the requirements of IFRS 17, this cost is not recognized immediately, but is reflected by a negative CSM of –100, which will be systematically allocated over time, as the reinsurance services are provided.

Strict application of the above principles may, in certain situations, lead to mismatches between the timing of recognition of losses on direct contracts and the timing of recognition of benefits from reinsurance. For example, if an insurer immediately recognizes a loss on a direct contract, but the benefits from reinsurance are recognized over time, the financial result of the period may be distorted. To avoid this situation, IFRS 17 introduces a specific exception.

Exception to Principle 5: If a reinsurance contract is held prior to or simultaneously with the recognition of a loss related to direct contracts, the insurer must immediately recognize a reinsurance income, to the extent that it compensates for that loss.

This provision ensures an appropriate correlation between the economic effects of direct contracts and those of reinsurance, contributing to a more faithful representation of financial performance (IFRS Foundation, 2018). Therefore, the treatment of the CSM in the case of reinsurance contracts highlights an essential adaptation of the principles of IFRS 17 to the particularities of this type of contract. Unlike direct contracts, where the CSM functions exclusively as a mechanism for deferring profit, in the case of reinsurance it becomes an instrument for distributing over time both the costs and the benefits associated with the transfer of risk.

Recognition of Contractual Service Margin in the profit and loss account

A key element of the model introduced by IFRS 17 is the way in which the Contractual Service Margin (CSM) is recognised in the profit and loss account. As previously highlighted, CSM cannot be recognised immediately, but must be distributed systematically over the term of the contract, as the insurance services are provided. The need for this rule is clearly explained by the IFRS Foundation (2018), which highlights the fact that, before the introduction of IFRS 17, profit recognition practices were inconsistent and difficult to compare across entities and jurisdictions. Some companies recognised profit at the inception of the contract, others at the end of the contract, and others distributed it arbitrarily over time. This lack of consistency significantly affects the quality of financial reporting. In this context, IFRS 17 introduces a service-based approach, whereby profit is recognised in correlation with actual economic activity.

To illustrate this logic, consider the example of a single premium annuity contract. Recognizing the full profit at the outset would create an unrealistic picture, while deferring it completely until the end would distort long-term financial performance. Gradual distribution of profit provides a balanced and relevant solution (International Accounting Standards Board, 2017). To determine how much of the CSM should be recognized in each period, entities use the concept of coverage units. These reflect the amount of insurance services provided and are determined based on the level of benefits and the duration of the contract (KPMG, 2020). Table 6 shows how they are determined and the calculation of the CSM amortization rate over the contract period.

Table 6. Determination of coverage units and CSM depreciation rate

Year	Estimated sum insured in force	Coverage units	Total units remaining	Depreciation rate
1	110	110	420	26.2%
2	95	95	310	30.6%
3	85	85	215	39.5%
4	70	70	130	53.8%
5	60	60	60	100%

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

In this example, the coverage units reflect the level of services provided annually. The amortization rate is determined as the ratio of the units related to the current period to the total units remaining. This is used to calculate the portion of the CSM that will be recognized as profit. The distribution of the coverage units shows a progressive decrease in their value, from 110 in the first year to 60 in the last, which leads to an increase in the amortization rate from approximately 26% to 100%. This reflects the concentration of services in the final periods of the contract.

Once the amortization rate is determined, it is applied to the adjusted CSM to calculate the amount recognized in the income statement. Table 7 illustrates this process, highlighting the evolution of the margin over a reporting period.

Table 7. Recognition of SCM in the profit and loss account

Elements	Value	Explanations
Initial CSM	120	Balance at the beginning of the period
Interest accretion (5%)	6	The effect of value over time
Changes related to future services	25	Favorable review
Adjusted CSM	151	120 + 6 + 25
CSM recognized in profit	(18)	Applying the depreciation rate (~12%)
Final SCM	133	Balance carried forward

Source: own elaboration based on the conceptual framework and valuation requirements provided by IFRS 17

In this example, only a portion of the CSM is recognized as profit in the current period, with the remainder carried forward to future periods. Starting from an adjusted CSM of 151, applying a depreciation rate of approximately 12% results in the recognition of a profit of 18 in the current period, resulting in a final CSM of 133. This evolution highlights the gradual transfer of profit to the income statement.

This mechanism helps to reduce the artificial volatility of financial results and to better align revenues with services provided (Deloitte, 2021). It is important to note that both the CSM and the coverage units must be reviewed periodically to reflect changes in estimates of future services. In the last year of the contract, the amortization rate reaches 100%, which leads to the complete depletion of the CSM and indicates that there are no more unearned profits.

By introducing the gradual recognition mechanism for CSM, IFRS 17 fundamentally transforms the way financial performance is reported in the insurance industry. Profit is no longer treated as a one-time event, but as the result of a continuous process, correlated with the services actually provided. This approach significantly contributes to improving the transparency and comparability of financial statements.

Conclusions

This paper analyzed the role of Contractual Service Margin (CSM) within IFRS 17, highlighting both its determination and adjustment mechanisms and the impact on profit recognition in insurance companies. The analysis shows that the introduction of CSM represents one of the most significant

changes brought by this standard, contributing to redefining the way in which financial performance is reflected in financial statements. By prohibiting the immediate recognition of profits and distributing them over the life of contracts, IFRS 17 ensures a more rigorous correlation between revenues and the insurance services actually provided. This mechanism contributes to reducing artificial volatility of results and improving the qualitative characteristics of financial information, in particular relevance and faithful representation. At the same time, the use of the concept of "coverage units" introduces a systematic framework for profit allocation, increasing comparability between entities and markets. At the same time, the distinct treatment of reinsurance contracts highlights the flexibility of the standard in adapting the general principles to the economic particularities of these instruments.

However, the literature and analysis highlight the existence of significant challenges. The high complexity of the CSM model, the reliance on actuarial estimates and the need for high-performance IT systems may affect the consistency and comparability of its application in practice. In addition, gaps persist in the academic literature regarding the assessment of the long-term impact of IFRS 17 on managerial behavior, profit recognition policies and international comparability (IFRS Foundation, 2018). In this context, future research could aim at: empirically analyzing the impact of the CSM on the volatility of financial results in different jurisdictions; investigating how actuarial estimates influence the consistency of reporting; exploring the link between IFRS 17 and the new sustainability and governance (ESG) reporting requirements; assessing the implications for strategic management decisions in the insurance industry.

In conclusion, the CSM is not just a technical element of IFRS 17, but a central mechanism that fundamentally transforms the recognition of financial performance in the insurance industry. It marks the transition from transaction-oriented accounting to service-oriented accounting, thus strengthening the role of financial reporting as an essential tool for informed economic decisions.

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RESEARCH AND DEVELOPMENT INTENSITY, CAPITAL EXPENDITURE INTENSITY, AND OPERATING PROFITABILITY: EVIDENCE FROM THE EUROPEAN AUTOMOTIVE INDUSTRY, 2005–2024

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Abstract: *This study examines whether research and development (R&D) intensity and capital expenditure (Capex) intensity are associated with operating profitability in the European automotive industry. Using firm-level data from the EU Industrial R&D Investment Scoreboard, the analysis covers an unbalanced panel of 852 firm-year observations from 153 European automotive firms over 2005–2024. Operating profitability is measured as operating profit relative to net sales, while R&D intensity and Capex intensity are calculated relative to net sales. The empirical strategy uses panel regression models with firm and year fixed effects, with standard errors clustered at the firm level. The results show that R&D intensity is negatively and significantly associated with contemporaneous operating profitability, suggesting that innovation-related expenditure may place short-term pressure on accounting performance. This relationship weakens after winsorizing extreme observations and does not persist in a one-year lagged specification, suggesting that the effect is mainly short-run. By contrast, Capex intensity shows a positive but statistically insignificant association with operating profitability in the preferred fixed-effects models. The findings indicate that R&D expenditure is more closely related to short-term accounting profitability than tangible capital investment; however, the negative coefficient should not be interpreted as evidence that R&D destroys value. Rather, it reflects short-term accounting pressure and the time lag between innovation expenditure and future returns, and the results should be interpreted cautiously due to sensitivity to outliers and timing effects.*

Keywords: *R&D intensity; capital expenditure; operating profitability; automotive industry; panel data; fixed effects.*

JEL: M41; G31; O32; L62.

Introduction

The European automotive industry is undergoing major technological transformation driven by electrification, digitalization, automation, stricter environmental regulation and changing consumer demand. The sector remains economically important for Europe, but its competitive position is increasingly challenged by new entrants, software-based differentiation and the transition from internal combustion engines to electrified powertrains (Cornet et al., 2023; Konrad and Stagl, 2018). These changes require firms to allocate substantial resources to both innovation-related investment and tangible capital investment.

Research and development (R&D) expenditure is central to automotive innovation, especially in areas such as electric vehicles, clean technologies, software, autonomous driving and safety systems. At the same time, capital expenditure (Capex) is necessary for plants, production capacity, equipment and the reconfiguration of manufacturing systems. Industry reports emphasize that high R&D spending, high Capex and regulatory costs can place pressure on profitability and pricing power in the automotive sector (Ferraris and Madlani, 2018).

This study asks whether R&D intensity and Capex intensity are associated differently with operating profitability in European automotive firms. The question is relevant because R&D may generate long-term competitiveness but reduce current accounting profit, while Capex may support production capacity but may not immediately improve operating margins. The paper contributes to applied financial accounting and corporate finance research by comparing the short-term profitability association of intangible innovation-related expenditure and tangible capital investment using firm-level panel data.

Literature Background and Hypotheses

Previous studies generally recognize innovation as an important driver of competitiveness and firm performance. Alt (2017), using evidence from the European automotive industry, reports that innovation indicators, including R&D intensity, are positively associated with return on assets. Ozer, Nazli and Yaniktepe (2019) also show that R&D expenditure in the automotive sector is related to sales and profitability measures, although the timing of these effects and the choice of performance indicators may influence the results.

From a theoretical perspective, the present study draws on the resource-based view of the firm. Barney (1991) argues that firm-specific resources and capabilities can support sustained competitive advantage when they are valuable, rare, difficult to imitate and effectively organized. In the context of automotive firms, technological knowledge, innovation capability, production assets and manufacturing capacity may therefore be viewed as strategic resources. However, their accounting effects may differ in the short run. R&D expenditure may reduce current profitability before innovation benefits are realized, while Capex may require time before new production capacity contributes to operating margins.

The short-term accounting effect of R&D can therefore differ from its long-term strategic value. Isik and Tasgin (2017) find that R&D costs can dampen profitability in manufacturing firms, suggesting that innovation expenditure may reduce current profit before benefits materialize. This view is particularly relevant for capital-intensive industries, where firms must continue investing in technology and product development even when immediate profitability is under pressure.

Capex has also been studied as a determinant of firm performance. Jaisinghani, Tandon and Batra (2018) examine the automobile industry and find a dynamic relationship between capital expenditure intensity and firm performance, highlighting the importance of appropriate investment levels. Aghion et al. (2012) show that environmental policy can redirect innovation in the auto industry toward cleaner technologies, while Rozendaal and Vollebergh (2024) provide further evidence that policy-induced innovation affects the direction of technological change in the car market. These studies suggest that R&D and Capex may both be important for competitiveness, but their short-term association with accounting profitability may differ.

Based on the reviewed literature, the study tests three hypotheses: H1: R&D intensity is significantly associated with operating profitability; H2: Capex intensity is significantly associated with operating profitability; and H3: the association between R&D intensity and operating profitability differs from the association between Capex intensity and operating profitability.

Research Methods Applied

The study uses firm-level data from the EU Industrial R&D Investment Scoreboard, published by the European Commission's Joint Research Centre (JRC). Hernandez et al. (2015) describe the Scoreboard as a source of economic and financial information on major corporate R&D investors and as a tool for monitoring corporate innovation activity. The analysis covers firms classified in the Automobiles & Parts sector over 2005–2024. Although the latest Scoreboard file used in this study is labelled 2025, the corresponding financial year is 2024; therefore, the empirical period ends in 2024.

The final baseline sample is an unbalanced panel of 852 firm-year observations from 153 European automotive firms. On average, each firm appears in the baseline sample for approximately 5.6 years,

reflecting the changing composition of Scoreboard firms over time. This unbalanced structure results from firm entry, exit, mergers, restructuring, changes in firm size and sector reclassification. Observations with missing values in the main regression variables and observations flagged for major validation issues are excluded from the baseline models.

Table 1. Variable definitions

Variable	Measurement	Role
Profitability	Operating profit / Net sales	Dependent variable
R&D intensity	R&D expenditure / Net sales	Main explanatory variable
Capex intensity	Capital expenditure / Net sales	Main explanatory variable
Firm size	Natural logarithm of net sales	Control variable

Source: Author's compilation based on EU Industrial R&D Investment Scoreboard data.

The baseline fixed-effects specification is:

$$Profitability_{it} = \beta_1 RDIntensity_{it} + \beta_2 CapexIntensity_{it} + \beta_3 FirmSize_{it} + \alpha_i + \lambda_t + \varepsilon_{it}$$

where i denotes the firm and t denotes the year. Firm fixed effects control for time-invariant firm characteristics, while year fixed effects control for common shocks affecting all firms in the same year. Firm size is measured as log net sales to reduce scale-related skewness and improve comparability across firms. Standard errors are clustered at the firm level to account for within-firm serial correlation. The models are estimated in R using the fixest package (Bergé, 2018).

Results and Discussions

Table 2 reports descriptive statistics for the main variables. The mean operating profitability is 5.06%, while the mean R&D intensity and Capex intensity are 6.14% and 5.16%, respectively. The wide range of profitability and R&D intensity indicates the presence of extreme observations, which motivates the use of robustness checks. Figure 1 visualizes this dispersion and shows that most observations cluster around moderate profitability levels, with a small number of extreme losses and gains.

Table 2. Descriptive statistics

Variable	Mean	SD	Min	Max
Profitability (%)	5.06	9.24	-78.80	80.92
R&D intensity (%)	6.14	8.31	0.16	99.81
Capex intensity (%)	5.16	3.61	0.00	28.65
Firm size	8.18	2.02	1.78	12.69

Source: Author's calculations based on EU Industrial R&D Investment Scoreboard data.

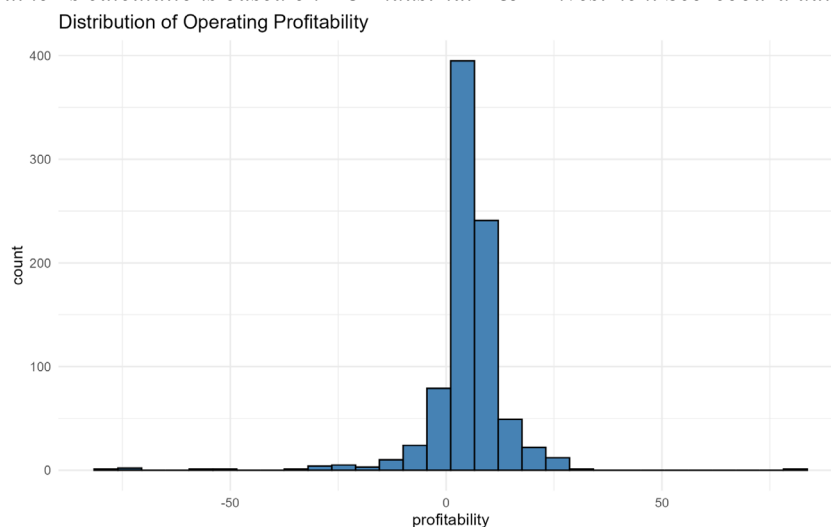


Figure 1. Distribution of operating profitability

Source: Author's calculations based on EU Industrial R&D Investment Scoreboard data.

The correlation matrix shows a negative correlation between R&D intensity and profitability (-0.301), while Capex intensity is positively but weakly correlated with profitability (0.186). The correlations among the explanatory variables are low, indicating no serious multicollinearity problem.

Table 3. Correlation matrix

Variable	Profitability	R&D intensity	Capex intensity	Firm size
Profitability	1.000	-0.301	0.186	0.190
R&D intensity	-0.301	1.000	-0.060	-0.283
Capex intensity	0.186	-0.060	1.000	0.157
Firm size	0.190	-0.283	0.157	1.000

Source: Author's calculations based on EU Industrial R&D Investment Scoreboard data.

Table 4 presents the baseline regression results. The preferred specification is the firm and year fixed-effects model, because it controls for both unobserved firm-specific characteristics and common time shocks. In this model, R&D intensity is negative and statistically significant. More specifically, a one-percentage-point increase in R&D intensity is associated with an approximately 1.4 percentage-point reduction in operating profitability, although this magnitude should be interpreted cautiously given the sensitivity to outliers. This finding should not be interpreted as evidence that R&D is harmful; rather, it suggests that innovation-related expenditure may place short-term pressure on accounting profitability before future benefits are realized.

Capex intensity is positive in the preferred model but statistically insignificant. Thus, the evidence does not support a robust short-term relationship between capital expenditure intensity and operating profitability once firm and year effects are controlled for. The difference between the pooled OLS and firm fixed-effects results suggests that the positive Capex-profitability relationship is stronger across firms than within firms over time. This may indicate that firms with structurally higher Capex intensity differ in scale, production systems or business models, while increases in Capex within the same firm do not immediately translate into higher operating profitability.

Table 4. Baseline regression results

Variable	Pooled OLS	Year FE	Firm + Year FE
R&D intensity	-0.296**	-0.313*	-1.398**
Capex intensity	0.398**	0.451*	0.148
Firm size	0.411**	0.336	-2.553
Observations	852	852	809
R ²	0.126	0.184	0.709
R ² (within)	—	0.139	0.169
Year FE	No	Yes	Yes
Firm FE	No	No	Yes

*Source: Author's estimations. Clustered standard errors are used where applicable. Significance: + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$. The reduction from 852 to 809 observations in the firm and year fixed-effects model reflects the removal of singleton fixed-effect observations by the estimator.*

Because the intensity variables are expressed in percentage terms, the coefficients should be interpreted as changes in operating profitability associated with a one-percentage-point change in investment intensity. The firm-size coefficient should be interpreted cautiously in firm fixed-effects models because much of the persistent size difference across firms is absorbed by firm fixed effects.

Robustness Checks and Discussion

Several robustness checks are conducted to assess whether the baseline findings are sensitive to outliers, timing effects, sample period, functional form, or alternative size measurement. Table 5 summarizes the main robustness models.

Table 5. Robustness regression results

Variable	Baseline FE	Winsorized FE	Lagged FE	2011–2024 FE	Log FE	Log Winsorized FE
R&D intensity	-1.398**	—	—	-1.051*	—	—
Capex intensity	0.148	—	—	0.071	—	—
R&D intensity (wins.)	—	-0.516+	—	—	—	—
Capex intensity (wins.)	—	0.179	—	—	—	—
R&D intensity (lag)	—	—	-0.137	—	—	—
Capex intensity (lag)	—	—	0.122	—	—	—
Log R&D intensity	—	—	—	—	-5.507*	—
Log Capex intensity	—	—	—	—	0.727	—
Log R&D intensity (wins.)	—	—	—	—	—	-3.451+
Log Capex intensity (wins.)	—	—	—	—	—	0.812
Observations	809	809	675	575	809	809
R ² (within)	0.169	0.030	0.019	0.155	0.026	0.019

*Source: Author's estimations. All models include firm and year fixed effects with firm-clustered standard errors. Significance: + $p < 0.10$; * $p < 0.05$; ** $p < 0.01$. An em dash (—) indicates that the variable is not included in that specification because an alternative transformation or lagged version is used.*

The winsorized specification shows that the R&D coefficient remains negative but becomes substantially smaller and only marginally significant (-0.516, $p < 0.10$), indicating sensitivity to extreme observations. The lower R² (within) in this specification suggests that outliers explain part of the within-firm variation in profitability. The one-year lagged model shows no significant coefficient for lagged R&D or lagged Capex, reducing but not eliminating concerns about timing and reverse causality. The 2011–2024 and log-transformed models confirm the negative R&D association, although the log winsorized model again shows weaker significance.

Additional robustness using an alternative firm-size proxy

To reduce the possibility that the results are driven by the use of net sales as the size control, an additional robustness specification replaces firm size, measured by log net sales, with an employee-based size proxy, measured as $\log(1 + \text{employees})$. This check is useful because sales may be affected by price cycles, product mix, and temporary demand shocks, while employment captures a more operational dimension of firm scale. The use of an employee-based size proxy leaves the main conclusion unchanged: R&D intensity remains negative and statistically significant, Capex intensity remains positive but insignificant, and the employee-based size measure is not significant. This confirms that the negative R&D-profitability association is not an artefact of using sales as the denominator.

Table 6. Additional robustness using employee-based firm size

Variable	Employee-size FE
R&D intensity	-1.334** (0.518)
Capex intensity	0.162 (0.158)
Employee size	-0.439 (1.269)
Observations	844
Firm FE / Year FE	Yes / Yes

Source: Author's estimations. Employee size is measured as $\log(1 + \text{employees})$. Clustered standard errors at the firm level are reported in parentheses. The observation count differs slightly because employee data are available for a different set of firm-year observations.

The results suggest that R&D intensity appears to be more consistently associated with short-term operating profitability than Capex intensity, although this association is negative and sensitive to outlier treatment. In the automotive industry, firms must continue investing in electrification, digitalization, automation, safety technologies and environmental innovation. These investments are strategically important but may not immediately translate into higher operating profitability. In addition, strong competition may force firms to sustain high R&D spending without immediate pricing power, further compressing short-term operating margins.

The Capex results are less robust. Although the coefficient is generally positive, it is not statistically significant in the preferred fixed-effects specifications. The different results for R&D and Capex may reflect the different accounting and operational timing of these expenditures. R&D is more directly reflected in current-period costs, whereas Capex is capitalized and its effect on profitability may appear gradually through depreciation, capacity utilization and production efficiency.

Limitations

This study has several limitations. First, the empirical analysis identifies associations rather than causal effects. Although firm and year fixed effects are used to reduce omitted-variable bias, the models do not fully address reverse causality between investment expenditure and profitability. Second, the sample is based on firms included in the EU Industrial R&D Investment Scoreboard, which mainly covers major R&D investors; therefore, the findings are more representative of relatively large and innovation-oriented automotive firms than of the entire European automotive industry. Third, the R&D result is partly sensitive to extreme observations, as shown by the weaker coefficient in the winsorized specifications. Some extreme observations appear to be driven by firms with very low net sales or unusually weak operating profit in specific years, which may amplify intensity ratios. In particular, the negative coefficient may be influenced by a small number of observations with unusually high R&D intensity and weak operating profitability. Finally, the models are limited by the variables available in the Scoreboard and do not fully control for financial structure indicators such as leverage, asset tangibility or liquidity.

Conclusions and Recommendations

This study examines whether R&D intensity and Capex intensity are associated with operating profitability in the European automotive industry over 2005–2024. Using an unbalanced panel of 852 firm-year observations from 153 firms, the study finds that R&D intensity is negatively associated with contemporaneous operating profitability in the preferred firm and year fixed-effects model. The relationship remains negative in the restricted 2011–2024 period and in the log-transformed model, but it weakens after winsorizing extreme values and does not remain significant in the one-year lagged specification. Taken together, the results indicate that the empirical contribution of the study lies not only in documenting the sign of the R&D coefficient, but also in showing how the interpretation changes across baseline, outlier-adjusted, lagged and alternative-size specifications.

Capex intensity shows no robust statistically significant association with operating profitability across the strongest specifications. Overall, R&D intensity appears to be more consistently associated with short-term operating profitability than Capex intensity, although this association is negative and sensitive to outlier treatment. The interpretation should therefore remain cautious: the results point to short-term accounting pressure from innovation-related expenditure, not to a definitive negative economic value of R&D. Future research may use longer lag structures, cumulative R&D capital measures, additional financial controls or instrumental-variable approaches to examine the long-term profitability effects of R&D investment.

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THE CREDIBILITY OF FINANCIAL AND ACCOUNTING INFORMATION IN THE DIGITAL ERA: BLOCKCHAIN-BASED CHALLENGES AND SOLUTIONS FROM THE PERSPECTIVE OF PROFESSIONALS

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Abstract: *The digital transformation of financial and accounting processes has generated growing interest in technologies capable of enhancing the credibility, transparency, and security of financial and accounting information. Among these, blockchain technology is considered one of the most important emerging technologies, with the potential to transform accounting and auditing practices. The purpose of this research is to analyze the perceptions of accounting professionals regarding the credibility of financial and accounting information in the context of digital transformations and to assess the potential of blockchain technology to contribute to increased transparency, security, and trust in financial and accounting information. The research is quantitative in nature and is based on a survey administered to 82 respondents from the fields of accounting, auditing, and academia. The research results highlight that respondents perceive blockchain as a technology with significant potential to increase transparency, data security, and trust in financial reporting. At the same time, the results indicate the existence of significant challenges regarding the implementation of this technology, including low levels of digital literacy, high implementation costs, and an inadequate regulatory framework. The research also highlights a low level of familiarity with blockchain technology at the national level.*

Keywords: *blockchain technology, financial-accounting information, digital transformation, accounting profession*

JEL: M41, O33

Introduction

The first and most significant application of blockchain technology was in the world of cryptocurrencies. It emerged with the launch of Bitcoin in 2009 as the technological infrastructure underpinning the new decentralized protocol (Sinha, 2019). Since its inception, blockchain technology has evolved beyond its initial application in the field of cryptocurrencies to encompass a wide range of industries and use cases. Blockchain is a system of distributed and decentralized ledgers that enables the transparent and immutable recording of transactions across a network of interconnected nodes; its fundamental principles include decentralization, immutability, transparency, and security (Prokopenko et al., 2024; Juneja, 2024). Therefore, decentralization eliminates the need for intermediaries by distributing the ledger across a network of participants; immutability ensures that, once recorded, data cannot be retroactively modified; transparency is achieved through real-time visibility of transactions for all network participants; and security measures, such as cryptographic hashing and consensus mechanisms, prevent unauthorized access and fraudulent activities (Prokopenko et al., 2024). Thus, the distributed database operates through the consensus of network participants and is capable of recording the entire history of transactions to guarantee data integrity and immutability (Cernea et al., 2022). Each transaction is encoded and added to an immutable chain of transactions, distributed to all ledgers (nodes) in the network and stored independently by each participant, so that all records are time-stamped, encrypted, interconnected, and impossible to modify subsequently (Pugna & Duțescu, 2020).

The original premise of blockchain technology is to establish trust within a peer-to-peer (P2P) network, eliminating the need for any type of third-party oversight through the use of verifiable

mathematical proofs. This trust mechanism allows participants in a P2P network to transact with one another without having direct trust in each other and without needing to know the real identities of the parties involved. A record of transactions between participants is stored in a chain consisting of data structures called blocks, hence the name „blockchain”, with each participant maintaining a copy of this record (Pratt, 2026). For this reason, blockchain is sometimes also referred to as distributed ledger technology (DLT). Each instance of this ledger, stored by every participant in the network, is updated simultaneously across the network, with no possibility of retroactively altering the records (Hassan et al., 2021).

Without a doubt, blockchain is one of the most „trendy” technologies today, with significant disruptive potential for the economic and social spheres, making it a topic of major interest for both industry and academia. At the same time, as a technology that has not yet reached maturity, most researchers focus on its technical aspects (Pugna & Duțescu, 2020). Currently, a review of the specialized literature reveals few scientific studies on the importance of blockchain technology in the field of accounting. However, it is evident that the accounting system is undergoing a continuous process of transformation, and scientific research can go hand in hand with the technological field in studying its current and future uses within organizations. In this endeavor, an ongoing dialogue between accounting and technology is necessary, given the growing impact of digitalization on the economic environment (Pedreño et al., 2021). Although both researchers and accounting professionals agree on the disruptive potential of blockchain technology, it is still unclear how these transformations will unfold, what challenges and risks they will bring along the way, and how they will affect the accounting profession (Pugna & Duțescu, 2020). Although blockchain technology is still in an experimental stage and faces challenges related to data processing capacity, information confidentiality, and regulation, in the long term its use could help reduce errors and the manipulation of financial results, improve the quality of financial and accounting information, and reduce information asymmetry (Yu et al., 2018).

In recent years, the limitations of traditional accounting systems, including issues related to data reconciliation, susceptibility to errors and fraud, and a lack of real-time transparency, have become increasingly apparent (Juneja, 2024). These challenges have underscored the urgency of identifying solutions capable of enhancing the efficiency, reliability, and transparency of financial reporting processes. In this context, blockchain technology emerges as a promising alternative, offering decentralized, immutable ledger systems that can revolutionize how financial transactions are recorded, verified, and reported. However, despite its potential, integrating blockchain technology into accounting practice is not without challenges. Concerns regarding scalability, interoperability, regulatory compliance, and stakeholders’ willingness to adopt emerging technologies present significant obstacles that must be addressed (Prokopenko et al., 2024).

In the field of financial accounting, traditional methods have long relied on centralized systems and manual processes for recording, reporting, and verifying financial transactions. Financial accounting serves as the cornerstone of economic decision-making, providing stakeholders with timely and accurate information about an entity’s financial position and performance (Yu et al., 2018). Financial accounting aims to record transactions, prepare financial statements, and ensure compliance with regulatory requirements. However, traditional accounting systems are often criticized for difficulties related to data reconciliation, susceptibility to errors and fraud, and a lack of real-time transparency. In this context, blockchain technology is being explored as an innovative solution capable of improving the efficiency, reliability, and transparency of financial reporting through a decentralized and immutable ledger, ultimately leading to more informed decision-making and greater trust among stakeholders (Prokopenko et al., 2024).

Currently, the accounting profession faces significant challenges arising from the development and implementation of blockchain technology. The accounting profession’s contribution should focus both on developing appropriate regulations and standards and on advising entities and other

stakeholders on the use of blockchain technology, as well as on optimizing internal processes and systems. New skills will be required, particularly in the technological, advisory, and analytical fields, including the ability to facilitate communication between technical staff and business stakeholders. Although blockchain poses certain challenges regarding transaction accounting, this technology can contribute to the transformation of the accounting profession by shifting the focus of work toward higher-value-added tasks, such as the analysis, evaluation, and interpretation of financial and accounting information. At the same time, transparency and rapid access to data will become essential attributes of professional practice (Pugna & Duțescu, 2020).

Given the rapid technological advances of recent decades, accounting professionals must possess digital skills, including knowledge of programming and data analysis. At the same time, they must understand emerging technological tools, use modern reporting techniques, and interpret financial and accounting information to meet reporting and regulatory requirements (Zhang et al., 2020). The literature agrees that financial robots are expected to take over a significant portion of basic accounting tasks in the future, as they represent an important component of the accounting landscape. Thus, accounting professionals must continuously improve their professional knowledge and skills, including technological abilities and the use of IT tools, to perform more challenging tasks. At the same time, education systems must respond appropriately by incorporating a higher level of technological competence (Zhang et al., 2020).

In this context, the purpose of this study is to analyze professionals' perceptions of the credibility of financial and accounting information in the context of digital transformation at the national level, as well as to assess the potential of blockchain technology to contribute to increased transparency, security, and trust in financial and accounting information.

Basic content

Literature review

Blockchain is an emerging technology capable of building trust among entities and reducing information asymmetry through the use of distributed ledger technology, thereby helping to increase efficiency and reduce costs (Li & Wan, 2021; Ameyaw et al., 2024).

Blockchain technology has attracted significant interest in academic and professional circles, becoming a key topic in the context of modernizing business processes, increasing transparency, and strengthening data security. In the field of accounting, this technology can bring about revolutionary changes by automating accounting processes, ensuring the immutability of financial records, and facilitating the transparent exchange of information among all participants, thereby strengthening trust and the efficiency of accounting practices. At the same time, the use of blockchain in financial and accounting information management can contribute both to data security and to the development of an ecosystem of mutual trust among all actors involved in the financial system (Snoussi Amouri, 2025). Thus, blockchain is based on three fundamental principles: transparency, data protection, and decentralization. The technology works by grouping transactions into blocks that are successively added to a chain of existing transactions through cryptographic mechanisms, where hashes and digital signatures are used for chain authentication (Giang & Tam, 2023). In this context, the use of blockchain technology has grown significantly over the past decade, continuing to evolve through the ongoing development of new features and functionalities (Fuller & Markelevich, 2019).

In the context of the Fourth Industrial Revolution (Industry 4.0), digital technologies are having a significant impact on financial and accounting processes and on the evolving role of accounting professionals, with an estimated 50% of repetitive accounting tasks set to be automated. The implementation of technology may lead to major transformations in the accounting profession by increasing the need for digital skills and intensifying collaboration between accounting professionals and information technology specialists (Giang & Tam, 2023). At the same time, according to Giang & Tam (2023), the major international audit firms (PwC, Deloitte, EY, and KPMG) have established

research committees dedicated to blockchain technology and its applications in the fields of accounting and auditing.

The role of accounting is to record and report an entity's economic activities. Although economic transactions occur continuously, financial and accounting information is processed and reported periodically, due to human intervention and the existence of conventional reporting periods. Increasing the frequency of updating accounting information, in order to continuously reflect economic transactions, can lead to difficult and time-consuming processes (Izzo et al., 2022).

Financial and accounting information is complex in nature, which imposes certain limitations on the use of blockchain technology. Although blockchain can be effective for certain types of transactions, the immutable nature of this technology can complicate the process of reviewing and correcting financial and accounting information. In practice, financial statements are frequently adjusted due to changes in estimates, the adoption of new accounting rules, or the identification of errors, and updating information in a blockchain-based system can become more difficult and costly (Fuller & Markelevich, 2019).

Reliability represent one of the fundamental qualitative characteristics of financial and accounting information, being essential for investors, auditors, and other users of financial reporting. A higher level of reliability contributes to strengthening confidence in financial statements and improving the credibility of the information presented. In this context, the literature highlights the growing interest in integrating blockchain technology into traditional accounting information systems. However, the actual impact of blockchain on the fields of accounting and auditing remains difficult to estimate, given the relatively recent and complex nature of this technology.

Blockchain can offer significant benefits in terms of increasing the reliability of financial and accounting information, an aspect of interest to both accountants and auditors, as well as investors. One of the main advantages of blockchain technology in the accounting field lies in the possibility of verifying financial and accounting information (Atadoga et al., 2024). Through distributed validation mechanisms, blockchain can help increase the credibility of information, particularly when verification is performed by independent entities. Unlike information controlled exclusively at the internal level, this type of verification can reduce the risk of subjective influences and strengthen confidence in the reported data (Fuller & Markelevich, 2019). For this reason, the literature highlights that blockchain has the potential to transform traditional approaches used in financial auditing.

In the same vein, Fuller & Markelevich (2019) point out that, although blockchain can offer numerous benefits, particularly in terms of data reliability and the auditing of financial statements, there are still many factors that raise questions about the widespread integration of this technology into the accounting field. Among the main challenges associated with integrating blockchain into accounting are the technology's scalability and the costs of its implementation. Although significant investments have been made in recent years to develop blockchain applications, there are still uncertainties regarding the economic efficiency and widespread applicability of this technology in the field of accounting. At the same time, the literature highlights concerns regarding data security and confidentiality. In this context, addressing these limitations is a key prerequisite for the widespread adoption of blockchain technology by accounting professionals and entities.

Although blockchain technology can help increase transparency, reduce certain errors, and create a ledger that is more resistant to tampering, it does not automatically guarantee the complete accuracy and fairness of financial statements. Ensuring the reliability of financial information in a blockchain-based accounting system requires combining technological mechanisms with rigorous audit procedures, compliance with the regulatory framework, and continuous monitoring of potential system vulnerabilities. Likewise, although it remains a polarizing and elusive technology for many, blockchain has gained considerable traction among accounting professionals. In the literature, the main components of blockchain technology applicable to accounting are considered to be smart

contracts, distributed and decentralized ledger technology, and the authorization of processes based on the digital validation of transactions (Giang & Tam, 2023).

Research methodology

The research methodology is based on the use of methods to scientific research in the socio-economic field, such as the analytical method, the synthesis method, the comparative method, the systemic method, and the questionnaire-based survey method. Thus, the research is quantitative and aims to analyze perceptions regarding the credibility of financial and accounting information in the context of digital transformations and the development of blockchain technology.

To collect data, a structured questionnaire was developed and distributed online to professionals in the fields of accounting, auditing, and academia. The questionnaire included both questions regarding the respondents' profiles and items designed to assess perceptions regarding the impact of digitization and blockchain technology on the credibility of financial and accounting information. The research instrument was structured into four main sections: respondent profile, the credibility of financial and accounting information in the digital age, blockchain and the accounting profession, and perspectives on the use of blockchain technology in the accounting field. Most items were formulated using a 5-point Likert scale, where 1 represents „strongly disagree” and 5 - „strongly agree”. The use of this scale made it possible to assess the respondents' level of agreement with the statements and to analyze their perceptions regarding the opportunities and challenges associated with digitalization and the implementation of blockchain technology.

The collected data were processed and analyzed using descriptive statistical methods, with the aim of identifying the main trends regarding respondents' perceptions of the credibility of financial and accounting information and the potential of blockchain technology to contribute to increased transparency, security, and trust in financial reporting.

The research aims to identify perceptions regarding the impact of digitization on the credibility of financial and accounting information and to analyze how blockchain technology is perceived as a potential solution for enhancing transparency, security, and trust in financial reporting. In this context, the research is guided by the following research questions:

RQ1. What are the respondents' main perceptions regarding the impact of digitization on the credibility of financial and accounting information?

RQ2. To what extent is blockchain technology perceived as a solution for increasing transparency, security, and trust in financial and accounting information?

RQ3. What are the main barriers and perspectives regarding the implementation of blockchain technology in the accounting field?

Results and discussion

Although the literature on blockchain technology has grown in recent years, research on its impact on the field of accounting remains underdeveloped. The literature highlights that integrating blockchain technology into accounting can help increase the security, transparency, and credibility of financial and accounting information (Giang & Tam, 2023). At the same time, the application of blockchain can positively influence the quality of entities' accounting information systems.

To conduct the research, responses were collected from 82 respondents in the fields of accounting, auditing, and academia. The results were analyzed using descriptive statistical methods, focusing on the main perceptions regarding the impact of digitization and blockchain technology on the credibility of financial and accounting information. Below, the research results are presented and interpreted according to the main dimensions analyzed in the questionnaire.

Respondent Profile and Familiarity with Digital Technologies

The survey was conducted based on responses from 82 participants in the fields of accounting, auditing, and academia. In terms of job titles, accountants predominated (32.9%), followed by financial analysts (18.3%) and chief accountants (14.6%). Additionally, the sample included auditors, financial experts, and faculty members, which contributed to the diversity of perspectives analyzed.

In terms of professional experience, respondents are relatively evenly distributed across the various experience categories, with those having 6–10 years of experience being the most common (25.6%). The results also highlight a high level of influence of digitalization on professional activity, with approximately 70% of respondents stating that their work is influenced to a large or very large extent by the digitalization process.

At the same time, most respondents consider themselves familiar or moderately familiar with the digital technologies used in the accounting and finance field, a finding that suggests an adequate level of knowledge regarding the digital context analyzed in the study.

The Credibility of Financial and Accounting Information in the Digital Era

In order to analyze respondents' perceptions regarding the impact of digitization on the credibility of financial and accounting information, the main benefits and risks associated with the use of digital technologies in the field of accounting were assessed. Respondents rated their level of agreement with a series of statements regarding access to information, the transparency of financial and accounting processes, the security of IT systems, and the risks associated with the digital environment. Thus, Table 1 presents the distribution of responses to the main statements analyzed in this section.

Table 1. Perceptions regarding the credibility of financial and accounting information in the digital era

Evaluated aspect	Disagreement (1-2)	Neutral (3)	Agreement (4-5)
Digitization has improved access to financial and accounting information	11,0%	14,6%	74,4%
The reliability of financial and accounting information depends on the security of the IT systems used	3,6%	8,5%	87,8%
In the digital age, there are greater risks associated with the manipulation or alteration of financial data	8,6%	19,5%	71,9%
Digital systems help increase the transparency of financial and accounting information	14,6%	9,8%	75,6%
Cyberattacks pose a significant threat to financial and accounting information	13,4%	12,2%	74,4%

Source: prepared by the author

The results presented in Table 1 show that respondents perceive digitization as having a significant impact on the credibility of financial and accounting information. Thus, 74.4% of respondents believe that digitization has improved access to financial and accounting information, and 75.6% believe that digital systems contribute to increased transparency of information.

At the same time, the research results reflect significant concerns regarding information security in the digital environment. A very high percentage of respondents (87.8%) believe that the credibility of financial and accounting information depends on the security of the IT systems used. At the same time, 74.4% of respondents believe that cyberattacks pose a significant threat to financial and accounting information.

The results also highlight the perception that there are increased risks of financial data being manipulated or altered in the digital age, a view shared by 71.9% of respondents. These results suggest that, although digitization is perceived as a factor contributing to the efficiency and increased transparency of financial and accounting processes, the development of the digital environment generates new challenges related to information security and protection.

Therefore, the results obtained in this section provide a relevant answer to RQ1, highlighting that respondents perceive digitalization as having a dual impact on the credibility of financial and

accounting information. On the one hand, digital technologies are associated with improved access to information, increased transparency, and greater efficiency in financial and accounting processes. On the other hand, the development of the digital environment raises significant concerns regarding data security, cyberattacks, and the potential for manipulation of financial information. Thus, the research findings suggest that maintaining the credibility of financial and accounting information in the digital age increasingly depends on the security, reliability, and protection of the information systems used.

Perceptions of Blockchain Technology in Accounting

In order to assess respondents' perceptions of the role of blockchain technology in the field of accounting, we analyzed both their general level of familiarity with this technology and their opinions regarding its impact on the transparency, security, and credibility of financial and accounting information.

The results of this section highlight the fact that respondents' familiarity with blockchain technology remains relatively low. Specifically, **54.9% of respondents stated that they had not previously heard of blockchain technology**, while only 45.1% indicated that they were familiar with the concept. These results suggest that, although blockchain technology is frequently discussed in the international academic literature and in the context of digital transformation, awareness and adoption of it in the field of accounting remain limited at the national level. At the same time, domestic research on the applicability of blockchain in accounting and auditing is still underdeveloped.

Similarly, the level of knowledge about blockchain technology is generally perceived as low or moderate. Approximately 56% of respondents believe they have a low or very low level of knowledge about the technology, while only about 11% consider themselves to have a good or very good level of knowledge. A significant portion of respondents (32.9%) consider their level of knowledge to be average, suggesting a growing interest in this technology, even though practical expertise remains limited.

Given the complexity of blockchain technology and the expectation of a relatively low level of familiarity with it in the accounting field, a brief explanatory overview of the concept was included in the questionnaire. Respondents were then asked to assess their own level of knowledge and familiarity with this technology; the results are presented in Figure 1.

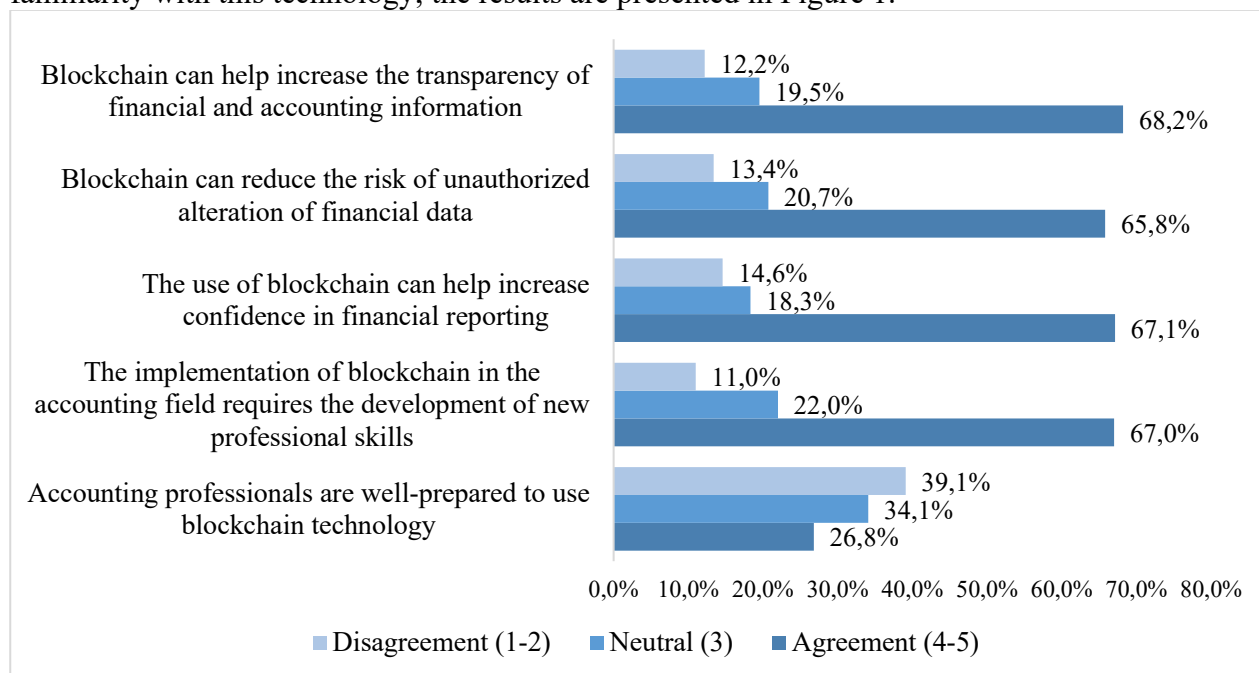


Figure 1. Perceptions regarding the role of blockchain technology in accounting

Source: prepared by the author

The results presented in Figure 1 highlight the fact that respondents perceive blockchain technology as having significant potential to improve the credibility of financial and accounting information. Thus, 68.2% of respondents believe that blockchain can help increase the transparency of financial and accounting information, and 67.1% believe that the use of this technology can help increase confidence in financial reporting.

At the same time, 65.8% of respondents believe that blockchain can reduce the risk of unauthorized modification of financial data, which highlights the association of this technology with the security and protection of financial and accounting information. The research results also indicate that the implementation of this technology in the field of accounting is perceived as requiring the development of new professional skills, a view supported by approximately 67% of respondents.

However, the results highlight a gap between the positive perception of blockchain's potential and the current level of professional readiness to use this technology. Thus, **only 26.8% of respondents believe that accounting professionals are sufficiently prepared to use blockchain technology**, while 39.1% disagree with this statement.

Consequently, the results obtained in this section provide a relevant answer to RQ2, highlighting that blockchain technology is perceived as a potential solution for increasing transparency, security, and trust in financial and accounting information. At the same time, the results suggest that the effective integration of this technology into the field of accounting depends on the development of professional competencies and the adaptation of specialists' training to new technological requirements (Ameyaw, 2024).

Barriers and Prospects for the Blockchain Implementation in Accounting

The final part of the study aimed to identify the main barriers associated with the implementation of blockchain technology in the field of accounting, as well as to assess the prospects for this technology's future impact on the accounting profession.

The results highlight that the main perceived barriers to the implementation of blockchain technology are a lack of digital knowledge and skills, as well as high implementation costs, with both issues cited by 51.2% of respondents. At the same time, 43.9% of them believe that the lack of regulations represents a significant obstacle to the integration of blockchain technology in the field of accounting. Other barriers identified by respondents included the complexity of the technology (36.6%), resistance to change, and difficulties integrating with existing systems (30.5%). In contrast, a lack of interest on the part of organizations was perceived as having little influence on blockchain implementation.

In the same vein, the international literature highlights the fact that, in addition to the advantages associated with transparency and security, blockchain technology also raises significant concerns regarding data privacy and compliance with regulatory requirements, including the GDPR. In particular, the distributed nature of the ledgers can create challenges in protecting sensitive information and controlling access to data. To this end, numerous information technology companies and international accounting firms have joined forces in an open-source collaboration to develop an advanced blockchain technology called Hyperledger. The project's main objectives focus on improving data security and strengthening information confidentiality in blockchain-based systems (Fuller & Markelevich, 2019). At the same time, Fuller & Markelevich (2019) highlight other potential challenges of implementing the technology, such as scalability issues, high implementation costs, and difficulties in integrating with existing IT systems. The authors point out that processing and distributing a large volume of transactions can affect the speed and operational costs of blockchain systems, particularly for large organizations. Furthermore, integrating the technology can generate additional costs related to consulting, staff training, data conversion, and the parallel operation of traditional and blockchain-based systems.

Looking ahead, the research findings reveal a generally positive perception of the impact of technology on the accounting profession. Approximately 49% of respondents believe that the future

impact of blockchain on the accounting profession will be high or very high, while **61% of respondents believe that this technology will become important for the accounting field over the next 10 years**. These results suggest that, despite the difficulties and challenges associated with implementation, respondents perceive blockchain as a technology with significant potential to transform the accounting field.

Therefore, the findings presented in this section provide a relevant answer to RQ3, highlighting that the main barriers to the implementation of blockchain in the accounting field are associated with a low level of professional training, high costs, and the lack of an adequate regulatory framework. At the same time, respondents express a positive view of the future prospects of blockchain technology and its impact on the accounting profession.

These findings are also supported by the academic literature, which highlights the many potential benefits of blockchain technology for the accounting and auditing fields. According to Fuller & Markelevich (2019), blockchain technology can help improve access to an entity's information for various categories of stakeholders, including auditors, investors, and regulators, as well as increase the transparency of financial and accounting information. The authors also highlight blockchain's potential to contribute to the standardization of information systems and to reduce costs associated with accounting and auditing processes. Furthermore, the continuous and transparent distribution of information can facilitate the development of continuous auditing and streamline the verification of financial and accounting information.

Conclusions

Blockchain technology is considered one of the most important emerging technologies, as it is associated with the potential to enhance trust between entities, reduce information asymmetry, and contribute to increasing the efficiency of economic processes. Although it is considered one of the leading emerging technologies, research on its applicability in the operations of entities remains limited. From an analysis, blockchain can contribute to increasing information transparency, reducing transaction costs, and strengthening trust between entities (Li & Wan, 2021).

With the advent of blockchain technology, a significant paradigm shift is taking place; this technology has the potential to transform traditional mechanisms for ensuring trust in financial and accounting information through traceability, immutability, and decentralized validation (Snoussi Amouri, 2025). At the same time, Snoussi Amouri (2025) states that improving the quality of financial and accounting information no longer depends exclusively on compliance with accounting standards and requirements, but increasingly on the use of digital technologies and the ability of entities to manage secure, transparent, and relevant information. Thus, blockchain technology is perceived as a tool with significant potential for strengthening trust in financial and accounting information and for streamlining accounting and audit processes.

The research findings highlight that respondents view digitalization both as a factor that improves access to information and the transparency of financial and accounting processes, and as a source of new challenges regarding data security and cyberattacks. Thus, blockchain technology is associated with multiple potential benefits, including reducing the risk of unauthorized data modification, increasing transparency, and strengthening trust in financial and accounting information. At the same time, the research findings indicate the existence of significant barriers to the implementation of blockchain technology in the field of accounting, particularly a lack of digital skills, high costs, and an inadequate regulatory framework (Ameyaw, 2024; Atadoga et al., 2024). Although the current level of familiarity with this technology remains relatively low at the national level, respondents express a generally positive perception of the future impact of blockchain on the accounting profession.

The research reviewed highlights the fact that the integration of blockchain technology poses significant challenges for the accounting profession, including in terms of the transformation of skills,

tools, and the way accounting activities are carried out. An increasing number of companies developing accounting software solutions are investing in blockchain-based technologies, a trend that is shaping the profile of the accounting professional and may lead to the emergence of new specializations in the fields of accounting and auditing (Giang & Tam, 2023).

Therefore, developing digital skills and increasing familiarity with emerging technologies, including blockchain, are essential for the accounting profession to adapt to new digital transformations. The research findings highlight the need to organize training programs, professional development courses, and educational initiatives at the national level, aimed at developing the digital skills of accounting professionals and familiarizing them with the applicability of blockchain technology in accounting and auditing.

In conclusion, the research findings can serve as a starting point for future research on the practical applicability of blockchain technology in the field of accounting and auditing. Given the emerging nature of the technology and its limited implementation in accounting practice, the topic offers multiple avenues for future research.

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TRENDS AND EMERGING RESEARCH DIRECTIONS IN ECONOMIC AND FINANCIAL ANALYSIS AND BUSINESS INNOVATION: A BIBLIOMETRIC APPROACH

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Abstract: *This study analyzes the evolution and conceptual structure of the scientific literature on economic and financial analysis and business innovation in the context of accelerated digital transformation, the development of artificial intelligence, and the expansion of intelligent financial ecosystems. The main objective of the study is to identify dominant trends, emerging research directions, and the conceptual relationships that structure the contemporary international literature in the economic, financial, and managerial fields. The research is based on bibliometric analysis and science mapping techniques, which are considered relevant methods for investigating interdisciplinary domains undergoing rapid development. The data collection process was conducted through the Web of Science database using a complex search query based on concepts related to financial performance, business innovation, digital transformation, and bibliometric analysis. Following the filtering process, the final sample included 64 scientific articles published between 2020 and 2026. The analysis was conducted using VOSviewer and Biblioshiny, examining the evolution of scientific production, keyword co-occurrence networks, thematic maps, and the relationships among authors, references, and dominant concepts.*

The results highlight a significant increase in scientific interest in digital finance, FinTech, business analytics, ESG, and business model innovation. Moreover, the study confirms that economic and financial analysis is evolving from traditional models toward intelligent, predictive, and sustainable approaches based on artificial intelligence, Big Data, and digital transformation. Thematic maps and conceptual networks indicate the consolidation of sustainability and digital transformation as central directions of contemporary research, as well as the emergence of new research areas related to intelligent financial ecosystems and organizational sustainable development.

Key words: *digital transformation; financial performance; business innovation; bibliometric analysis; FinTech; sustainability.*

JEL: M41, O31, O33, C88

Introduction

The transformations generated by digitalization, artificial intelligence, advanced data analytics, and the development of digital financial ecosystems have significantly changed economic and financial analysis processes and the way organizations operate. Recent literature highlights that digital technologies no longer represent only operational tools, but strategic factors influencing financial performance, competitiveness, and firms' capacity for innovation. In this context, Bresciani et al. (2021) demonstrate that digital transformation stimulates product, process, and business model innovation, contributing to the redefinition of traditional mechanisms of economic value creation. Furthermore, Zhai et al. (2022) emphasize the positive impact of digitalization on organizational performance and firms' competitive advantage.

The expansion of intelligent technologies and the development of artificial intelligence have led to the emergence of new paradigms in financial analysis and decision-making. Akour et al. (2024) highlight that artificial intelligence contributes to improving financial decision-making processes in emerging economies, while Gyau et al. (2024) demonstrate the positive impact of AI technologies on banks' financial performance. Moreover, Awwad (2024) and Moro-Visconti (2024) emphasize that the AI revolution is generating significant transformations in research, management, and economic value assessment, accelerating the development of intelligent organizational models.

The development of FinTech ecosystems and digital financial services has led to the restructuring of relationships between technology, financial management, and organizational innovation. Gomber et al. (2018) define the FinTech revolution as a process of structural transformation in financial services driven by the convergence of innovation and digitalization. Furthermore, Scardovi (2017) and Hill (2026) emphasize that the integration of intelligent technologies contributes to the transformation of financial institutions and to the development of economic ecosystems characterized by automation, flexibility, and a high level of interconnectedness.

At the same time, contemporary research highlights an increasing focus on integrating Big Data analytics, business analytics, and dynamic capabilities into organizational performance analysis. Wamba et al. (2017) demonstrate that large-scale data analytics contributes to improving firm performance through the development of dynamic capabilities, while Yoshikuni et al. (2023) confirm the role of business analytics in fostering innovation and organizational adaptability. These findings suggest that economic and financial analysis is evolving from traditional approaches toward predictive and intelligent models based on advanced data processing.

Moreover, recent literature highlights the expansion of research on business model innovation and organizational sustainability. Taran et al. (2021) emphasize that business model innovation involves integrated organizational and managerial transformations, while Ibrahim et al. (2026) underline the role of entrepreneurial leadership in supporting innovation and sustainability in small and medium-sized enterprises. Furthermore, Silva et al. (2026) analyze the impact of the Society 5.0 concept on the intelligent transformation of organizations and digital economic ecosystems.

Another important research direction concerns the relationship between digital transformation, financial innovation, and sustainable development. Li and Wei (2024) demonstrate that digital transformation stimulates enterprise growth, while Zhang et al. (2024) highlight the role of digital finance in supporting innovation and business environment development. In addition, Zhang et al. (2026) confirm that managerial orientation toward digitalization positively influences sustainable development and the integration of ESG principles into organizational strategies.

Despite the rapid development of the literature on economic and financial analysis, digital transformation, and business innovation, existing research remains conceptually and methodologically fragmented, making it difficult to identify the main research directions and thematic relationships without the use of specialized bibliometric tools. The growing number of publications and the interdisciplinary nature of the field highlight the need for a rigorous systematization of existing knowledge.

From this perspective, bibliometric analysis enables the investigation of relationships among concepts, authors, and dominant thematic directions, facilitating the identification of research clusters and emerging trends. Such an approach is particularly relevant in a continuously evolving field, where the convergence of artificial intelligence, digital transformation, FinTech, and business innovation is redefining the foundations of contemporary economic and financial management.

Based on these considerations, This article aims to provide a bibliometric analysis of research on economic and financial analysis and business innovation, with the objective of identifying the main scientific trends, emerging research directions, and conceptual relationships that structure recent international literature. At the same time, the study seeks to highlight how digitalization, artificial

intelligence, and business analytics influence the evolution of economic and financial research in the context of the global digital economy.

Therefore, the main contribution of the article lies in providing an integrated perspective on the evolution of research in economic and financial analysis and business innovation, emphasizing how digitalization, artificial intelligence, and new organizational models are transforming the theoretical and practical foundations of contemporary economic management.

Research Methodology

The research methodology is based on the use of bibliometric analysis, an approach that enables the systematic investigation of the evolution of scientific knowledge, the identification of major thematic directions, and the highlighting of emerging trends in the field of economic and financial analysis and business innovation. The choice of this method is justified by the interdisciplinary and dynamic nature of the researched domain, situated at the intersection of financial performance, digital transformation, organizational innovation, and intelligent technologies, as emphasized in the recent literature by Bresciani et al. (2021), Gomber et al. (2018), Wamba et al. (2017), Zhai et al. (2022), and Zhang et al. (2026).

The data collection process was conducted through the Web of Science database using a combination of keywords relevant to the research topic. The search strategy was designed to simultaneously capture the economic and financial dimension, the innovation and digital transformation component, as well as the bibliometric approaches applied in recent literature related to artificial intelligence, FinTech, business analytics, and business model innovation (Akour et al., 2024; Gyau et al., 2024; Taran et al., 2021; Yoshikuni et al., 2023). The search equation used to identify the publications was as follows: *("economic performance" OR "financial performance" OR "financial analysis") AND ("business innovation" OR "digital transformation" OR "innovation strategy") AND ("bibliometric analysis" OR "science mapping" OR "co-citation analysis") AND ("research trends" OR "emerging trends" OR "future research directions")*.

The application of the search equation for the 2020–2026 period initially generated a total of 103 scientific publications. Subsequently, the filtering process was carried out based on criteria such as scientific relevance, publication type, accessibility of bibliographic information, and thematic consistency with the research objectives. After excluding redundant studies, publications insufficiently related to the investigated topic, and incomplete documents, the final analyzed sample consisted of 64 scientific articles.

The final selection focused primarily on articles indexed in international journals relevant to the fields of business, finance, management, innovation, digital economy, and financial technology. In addition, studies explicitly addressing the relationship between digital transformation, financial performance, artificial intelligence, business innovation, digital finance, and organizational sustainability were included. In this context, the works developed by Li and Wei (2024), Yao and Yang (2026), Zhang et al. (2024), Silva et al. (2026), and Ibrahim et al. (2026) contributed to shaping the main conceptual dimensions investigated in the study.

The bibliometric analysis was conducted using science mapping techniques, which enable the investigation of the conceptual and intellectual structure of research on economic and financial analysis and business innovation. The need for such an approach is driven by the rapid expansion of studies related to digital transformation, FinTech, business analytics, business model innovation, and organizational sustainability, as highlighted in the literature by Gomber et al. (2018), Scardovi (2017), Wamba et al. (2017), Bresciani et al. (2021), Moro-Visconti (2024), and Zhang et al. (2026).

In order to identify dominant trends and emerging research directions, relationships among publications, authors, concepts, and relevant bibliographic sources from the international literature were analyzed. For the visualization and interpretation of bibliometric relationships, the applications VOSviewer and Biblioshiny were used. These tools enabled the development of keyword co-

occurrence networks, thematic maps, and the identification of research clusters, providing an integrated perspective on the evolution of the scientific literature.

From an analytical perspective, the research aims to identify the main trends and emerging directions in economic and financial analysis and business innovation driven by digitalization, artificial intelligence, Big Data, FinTech, and organizational sustainability. Thus, the adopted methodology enables the synthesis and mapping of the conceptual transformations shaping contemporary research in the economic and financial fields.

Basic content

In order to highlight the structure and dynamics of research on economic and financial analysis and business innovation, a bibliometric analysis was conducted on publications indexed during the 2020–2026 period. The results reflect the growing scientific interest in the impact of digital transformation, artificial intelligence, and organizational innovation on entities' economic and financial performance. At the same time, bibliometric indicators allow the assessment of the field's maturity, the level of academic collaboration, and the development pace of contemporary scientific literature. The analysis reveals that the investigated field is experiencing accelerated expansion, characterized by a continuous increase in the number of publications and the diversification of research topics. In this context, the bibliometric results provide a relevant overview of the main research trends and emerging directions generated by the convergence of digital technologies, financial analysis, and business innovation.



Figure 1. General indicators of the bibliometric research

Source: authors' own elaboration based on the bibliometric analysis performed in Biblioshiny using data from the Web of Science Core Collection for the 2020–2026 period

The final analyzed sample includes 64 scientific documents published during the 2020–2026 period, originating from 38 relevant academic sources. The annual publication growth rate of 30.77% highlights the increasing scientific interest in this interdisciplinary research area.

From the perspective of academic collaboration, the analyzed publications involve 177 authors, with only 10 articles being single-authored. Furthermore, the co-authorship index of 2.91 authors per document reflects the interdisciplinary nature of the research and the need to integrate expertise from the fields of finance, management, and digital technologies. Another relevant indicator is the international collaboration coefficient of 18.75%, suggesting that issues related to digital transformation and business innovation are addressed from a global perspective through cooperation among researchers and institutions from different countries. Regarding the conceptual structure of the field, the bibliometric analysis identified 217 author keywords, confirming the thematic diversity and conceptual complexity of the investigated research. The high frequency of terms associated with digital transformation, artificial intelligence, FinTech, business innovation, ESG, and financial performance indicates the current orientation of the literature toward intelligent and sustainable organizational development models. At the same time, the total number of 3,491 bibliographic references reflects the solid theoretical foundation of the analyzed publications and the high level of

integration of contemporary research into international scientific knowledge networks. An average of 22.16 citations per document confirms the academic relevance and impact of the studies included in the analysis, suggesting that the investigated topic benefits from significant visibility in the international literature.

Moreover, the average age of the documents, estimated at 2.03 years, highlights the current and dynamic nature of the analyzed field. This indicator confirms that the literature on economic and financial analysis, digital transformation, and business innovation is in a continuous process of development, directly influenced by technological advancements and global economic changes.

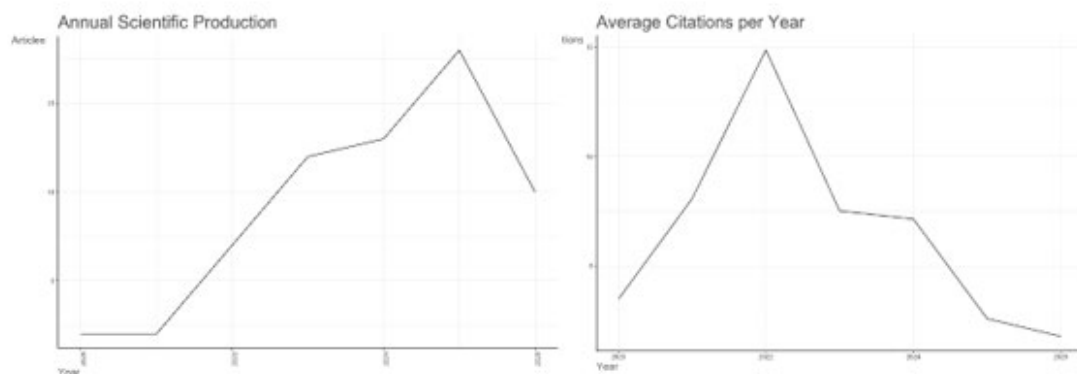


Figure 2. Evolution of scientific production and average citations in the field of economic and financial analysis and business innovation during the 2020–2026 period

Source: authors' own elaboration based on the bibliometric analysis performed in Biblioshiny using data from the Web of Science Core Collection for the 2020–2026 period

Figure 2, illustrating annual scientific production and average citations, highlights the accelerated evolution of research in the field of economic and financial analysis and business innovation, confirming the emerging and interdisciplinary nature of this scientific area. The increase in the number of publications during the 2020–2025 period reflects the growing academic interest in the impact of digital transformation, artificial intelligence, and innovative models on organizational and financial performance. The growth in scientific production after 2021 indicates the expansion of research related to FinTech, Big Data, business model innovation, and organizational sustainability, while the peak number of publications recorded in 2025 suggests the consolidation of the field within the contemporary digital economy.

At the same time, publications from the 2021–2022 period show the highest average citation levels, demonstrating their role in establishing the conceptual foundations for subsequent research on digital transformation and organizational innovation. The decline in average citations during the 2024–2026 period can be explained by the recent nature of these publications, which is characteristic of rapidly developing research fields. Therefore, the figure confirms both the growing scientific interest in the relationship between economic and financial performance and digital innovation, as well as the consolidation of a conceptual foundation supporting the development of contemporary research in this field.

The thematic map (Figure 3) highlights the conceptual structure of research on economic and financial analysis and business innovation, enabling the identification of dominant themes, emerging directions, and areas undergoing consolidation or decline. The representation is based on two main dimensions: centrality, which reflects the importance of a theme within the analyzed field, and density, which indicates the level of maturity and conceptual cohesion of the thematic cluster. The analysis of the results shows that themes related to sustainability, information, and ESG are positioned within the "Motor Themes" quadrant, indicating a high level of both relevance and conceptual development. This result confirms that sustainability and ESG-related issues represent one of the

most consolidated and influential directions in contemporary research. The integration of sustainability into economic and financial analysis reflects the literature's orientation toward intelligent, responsible, and sustainable organizational models aligned with the objectives of the digital economy and sustainable development.

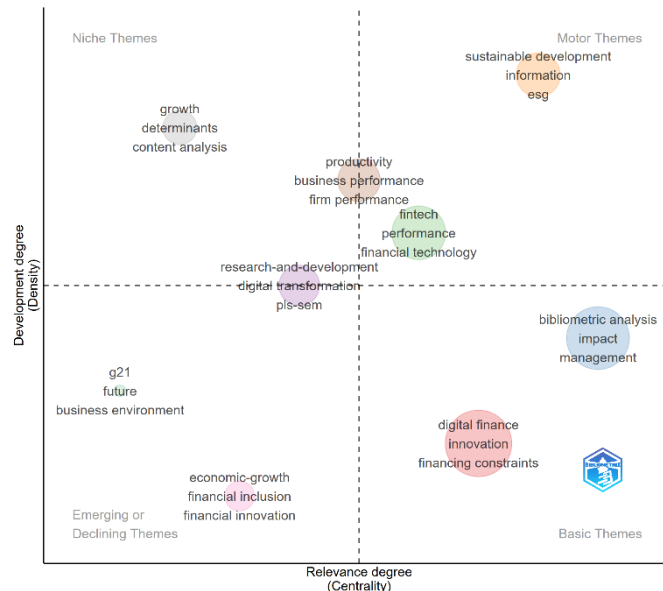


Figure 3. Thematic map of research on economic and financial analysis and business innovation during the 2020–2026 period

source: authors' own elaboration based on the bibliometric analysis performed in biblioshiny using data from the Web of Science Core Collection for the 2020–2026 period

The central thematic area also includes concepts such as “fintech,” “financial technology,” “performance,” and “business performance,” highlighting the role of financial technologies and digital transformation in redefining organizational performance. Their positioning suggests that these themes represent the current core of research, linking traditional financial analysis with new digital paradigms. Within the “Basic Themes” quadrant, themes such as “bibliometric analysis,” “management,” “digital finance,” “innovation,” and “financing constraints” are identified, reflecting the growing interest in the impact of digitalization on financial management and organizational financing mechanisms. The presence of the concept “bibliometric analysis” confirms the consolidation of bibliometric approaches as relevant tools for exploring the structure and evolution of scientific research.

The “Niche Themes” quadrant includes terms such as “growth,” “determinants,” and “content analysis,” indicating the existence of specialized and conceptually well-developed subfields that are less connected to the core research area.

In contrast, the “Emerging or Declining Themes” quadrant highlights concepts such as “financial inclusion,” “financial innovation,” “economic growth,” “business environment,” and “future,” suggesting the emergence of new research directions at an early stage of development. However, in the context of accelerated digital transformation and the expansion of intelligent financial ecosystems, these themes are more likely to represent emerging research directions with significant future development potential.

Overall, the thematic map confirms that contemporary research on economic and financial analysis and business innovation is evolving toward an interdisciplinary approach in which digital technologies, sustainability, artificial intelligence, and business model innovation become central elements of organizational performance. At the same time, the results highlight the transition from

traditional financial models toward intelligent economic ecosystems focused on digitalization, predictive analytics, and sustainable development.

Figure 4 highlights the keyword co-occurrence network used in the literature on economic and financial analysis and business innovation, illustrating the conceptual connections among the main themes investigated during the 2020–2026 period. The bibliometric representation enables the identification of dominant thematic clusters, relationships among concepts, and the interdisciplinary directions that structure contemporary research.

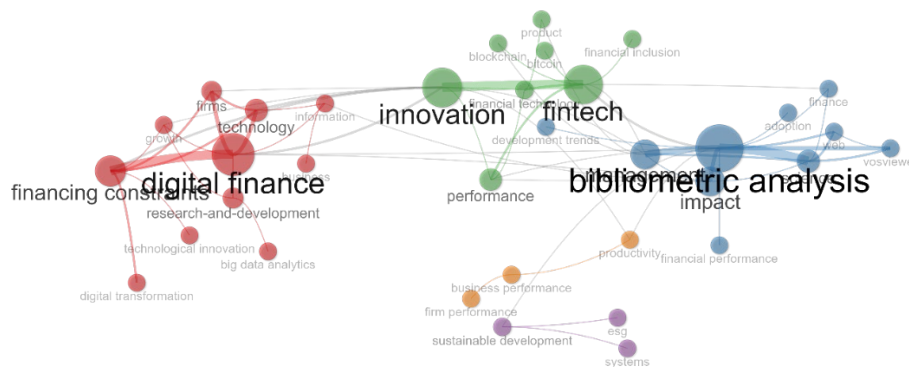


Figure 4. Keyword co-occurrence network in research on economic and financial analysis and business innovation

Source: authors' own elaboration based on the bibliometric analysis performed in Biblioshiny using data from the Web of Science Core Collection for the 2020–2026 period

The results highlight the existence of several interconnected conceptual clusters, confirming the interdisciplinary nature of the analyzed field. The most visible cluster is centered on the concept of “bibliometric analysis,” associated with terms such as “finance,” “financial performance,” “adoption,” and “VOSviewer,” emphasizing the role of bibliometric approaches in investigating the relationships among digital transformation, financial performance, and organizational innovation.

Another important cluster is represented by the concept of “digital finance,” connected with terms such as “big data analytics,” “digital transformation,” “technology,” and “research-and-development.” This result reflects the growing interest in the impact of digitalization on financial mechanisms and organizational innovation processes.

The cluster associated with the terms “innovation” and “fintech” highlights another dominant research direction, confirming that technological innovation and FinTech ecosystems influence the transformation of the financial sector and organizational competitiveness.

At the same time, the figure also highlights emerging clusters related to sustainability and organizational performance through concepts such as “sustainable development,” “ESG,” “firm performance,” and “business performance,” reflecting the integration of sustainability into financial analysis and organizational strategies.

Overall, the keyword co-occurrence network confirms the orientation of contemporary literature toward an integrated approach influenced by digital transformation, artificial intelligence, FinTech, Big Data, and sustainability. At the same time, the network structure highlights the growing interest in intelligent financial ecosystems and sustainable business models within the context of the global digital economy.

Figure 5 highlights the relationships among frequently used bibliographic references, publication authors, and dominant keywords in the literature on economic and financial analysis and business innovation. The visual structure reflects the intellectual and conceptual connections underlying

contemporary research, providing an integrated perspective on how theoretical sources, authors' contributions, and emerging themes are interconnected within the analyzed field.

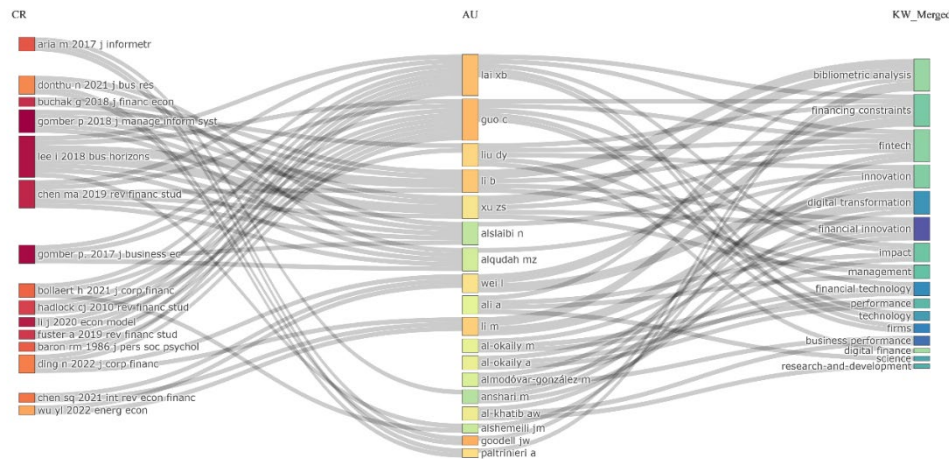


Figure 5. Relationships among references, authors, and keywords in research on economic and financial analysis and business innovation

Source: authors' own elaboration based on the bibliometric analysis performed in Biblioshiny using data from the Web of Science Core Collection for the 2020–2026 period

The network analysis demonstrates the existence of strong connections between contemporary authors and the foundational literature on digital transformation, FinTech, organizational innovation, and financial performance. The references located on the left side of the figure include highly influential studies that contributed to the development of the conceptual framework of the field, particularly research related to FinTech, business innovation, digital transformation, and innovation management. The frequent presence of sources such as the works of Gomber, Bresciani, Barney, and Bharadwaj confirms their role in shaping current paradigms of digitalization and business model transformation.

The central area of the figure is represented by authors contributing to the development of recent research, highlighting the existence of collaboration networks and shared research directions. The multiple connections among authors and references indicate that the current literature is built upon an interdisciplinary theoretical foundation integrating elements from management, finance, information technology, and organizational innovation.

On the right side of the figure, the dominant research keywords are highlighted, including “bibliometric analysis,” “fintech,” “digital transformation,” “financial innovation,” “performance,” “business performance,” and “research-and-development.” The high frequency and interconnectedness of these terms confirm that digital transformation and financial innovation represent the main conceptual cores of the analyzed literature.

The relationships between authors and keywords reveal the orientation of research toward investigating the impact of digital technologies on organizational performance and modern financial mechanisms. At the same time, the connections among the concepts of “financial innovation,” “digital finance,” and “research-and-development” suggest an expansion of research beyond traditional financial analysis toward intelligent and adaptive models of economic development.

The figure also highlights the consolidation of bibliometric approaches as tools for exploring the intellectual structure of the field. The frequent association of the term “bibliometric analysis” with other central concepts indicates the growing interest in mapping thematic relationships and identifying emerging trends within the economic and financial literature.

Overall, the results confirm that research on economic and financial analysis and business innovation is characterized by a high degree of interdisciplinarity and by an increasing convergence between digital technologies, financial performance, and innovative organizational development strategies. At the same time, the relational structure of the figure suggests that future research directions will be dominated by the integration of artificial intelligence, FinTech ecosystems, and sustainability into modern models of economic and managerial analysis.

Conclusions

The conducted bibliometric analysis highlights that research on economic and financial analysis and business innovation experienced accelerated development during the 2020–2026 period, driven by the intensification of digitalization processes, the advancement of artificial intelligence, and the transformation of economic and financial ecosystems. The obtained results confirm the interdisciplinary nature of the investigated field and demonstrate an increasing convergence among financial analysis, business innovation, digital transformation, FinTech, Big Data analytics, and organizational sustainability.

The continuous growth of scientific production and the diversification of thematic clusters confirm that contemporary literature goes beyond traditional approaches focused exclusively on the retrospective evaluation of financial performance. Instead, current research is oriented toward intelligent and predictive models of economic and financial analysis based on the integration of digital technologies, business analytics, and artificial intelligence into managerial and decision-making processes. The results of the thematic maps and concept co-occurrence networks reveal that digital transformation, digital finance, business model innovation, and sustainability represent the dominant cores of recent research. At the same time, the conceptual analysis demonstrates that emerging research directions are associated with the development of intelligent financial ecosystems, the integration of ESG criteria into performance management, and the use of advanced technologies to optimize organizational competitiveness. At the same time, the results suggest that the literature on economic and financial analysis is evolving toward a holistic perspective in which organizational performance is assessed not only through traditional financial indicators, but also through firms' ability to leverage digital transformation, innovation, and strategic sustainability. This trend reflects the transition toward a data-driven economy characterized by intelligent automation and digital interconnectedness.

The main contribution of the research lies in providing an integrated perspective on the evolution of the literature on economic and financial analysis and business innovation through the use of science mapping and bibliometric analysis techniques. The study contributes to the systematization of existing knowledge, the identification of major research directions, and the highlighting of conceptual relationships among digital transformation, financial performance, and organizational innovation.

Furthermore, the research makes an important contribution by identifying and delimiting the dominant and emerging thematic clusters structuring contemporary literature, emphasizing the central role of artificial intelligence, FinTech, business analytics, and sustainability in redefining modern economic and financial paradigms. By integrating analyses of scientific production, conceptual networks, and thematic maps, the article provides a comprehensive overview of the conceptual transformations shaping current research in the economic and managerial fields.

At the same time, the obtained results may serve as a relevant reference for both researchers interested in emerging directions within the economic and financial literature and practitioners and decision-makers involved in digital transformation and organizational innovation processes. In this regard, the research contributes to strengthening the theoretical foundation necessary for the development of modern economic and financial analysis models adapted to the digital economy and intelligent business ecosystems.

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FINANCIAL RESILIENCE OF IT ENTITIES IN THE CONTEXT OF PROJECT-ORIENTED BUSINESS MODELS

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Abstract: *The research addresses the issue of financial resilience of IT entities in the context of project-oriented business models, aiming to identify the main research directions, dominant concepts, and the relationships between digital transformation, organizational flexibility, and the financial sustainability of companies operating in the information technology sector. The relevance of the topic stems from the increasing economic and technological uncertainties, the dependence of IT companies on intellectual capital and intangible assets, as well as the volatility of revenues generated by project-based activities. The research methodology is based on a bibliometric and conceptual analysis of the international scientific literature indexed in Web of Science. The study selection process was conducted according to the PRISMA methodological framework adapted to bibliometric analysis, using the Biblioshiny tool from the Bibliometrix package. The application of the search query and thematic filters related to the fields of "Management", "Business", "Business Finance", and "Economics" enabled the identification of a final bibliometric corpus of 26 scientific papers, of which 14 studies with high conceptual relevance were selected for in-depth analysis. The findings reveal that the international literature predominantly approaches the resilience of IT companies through the perspectives of digital transformation, dynamic capabilities, organizational flexibility, and agile business models. At the same time, the conceptual and thematic analysis identified significant gaps regarding the integration of the financial dimension into studies dedicated to project-oriented companies. This study provides an integrated perspective on the financial resilience of IT entities by correlating organizational, technological, and financial dimensions within a unified conceptual framework.*

Key words: *financial resilience, IT companies, project-based business models, organizational resilience, digital transformation, dynamic capabilities*

JEL: M41, G32, O33, L86, M15, D22

Introduction

Digitalization-driven transformations and the intensification of economic and technological uncertainties have led to a reconsideration of how companies build stability and adaptive capacity. In this context, organizational and financial resilience has become an important direction of international research, particularly within the IT sector, characterized by high volatility and project-oriented business models. According to Sincora et al. (2023), organizational resilience is influenced by process maturity and by the ability of entities to integrate adaptive mechanisms into operational activities. The specific nature of IT companies generates challenges related to operational continuity, financial flexibility, and responsiveness to technological changes. Additionally, project-oriented business models involve revenue fluctuations and greater exposure to operational and financial risks. In this regard, Coiciu and Militaru (2024) emphasize that the integration of digital business continuity systems and the development of cyber resilience contribute to strengthening the ability of digital organizations to manage technological disruptions. The international literature highlights that the resilience of IT companies is influenced by factors such as digital transformation, dynamic capabilities, organizational flexibility, project management, and the effective use of intellectual capital.

In this context, recent studies emphasize the role of agile business models and adaptive capacity in strengthening organizational competitiveness. In this regard, Li, Li, and Ding (2025) demonstrate that digital transformation positively contributes to organizational innovation and the development of adaptive capabilities, thereby enhancing the resilience of technology-oriented companies.

However, the specialized literature reveals the existence of gaps in the integrated approach to the financial resilience of IT entities. Most studies examine resilience predominantly from organizational, operational, or technological perspectives, while the financial dimension remains insufficiently explored. Furthermore, limited attention is given to the relationships between financial flexibility, the volatility of project-based revenues, and the specific characteristics of agile business models in the IT sector. The relevance of the topic stems from the intensification of risks associated with the digital environment, including cyber vulnerabilities, rapid technological changes, and competitive pressures generated by the digital economy. Under these conditions, the ability of IT companies to adapt organizational structures and maintain financial stability becomes essential for ensuring business continuity and long-term competitiveness.

The aim of the research is to analyze the financial resilience of IT entities in the context of project-oriented business models by identifying the main thematic directions and the relationships between organizational flexibility, digital transformation, and financial sustainability. In this regard, the study employs a bibliometric and conceptual analysis of the international scientific literature indexed in Web of Science in order to identify dominant research trends and existing gaps within the analyzed field.

Methodologically, the research is based on the use of the Biblioshiny tool from the Bibliometrix package and on the application of a literature selection procedure according to the PRISMA framework adapted to bibliometric analysis. Following the filtering process, 26 relevant studies were identified, of which 14 papers with high conceptual relevance were used to substantiate the thematic directions related to organizational and financial resilience, adaptive capacity of digital entities, financial sustainability, agile business models, and IT project management.

The research findings contribute to a deeper understanding of the relationship between financial resilience and the specific characteristics of project-oriented IT companies, highlighting the need for integrated approaches that correlate financial performance, operational flexibility, digital transformation, and the adaptive capacity of digital entities.

Research methodology

The research methodology was designed to ensure the rigorous identification and selection of scientific papers relevant to the analysis of the financial resilience of IT entities in the context of project-oriented business models. In this regard, the study was conducted using the Web of Science database, considered one of the most relevant international sources for academic studies in the fields of management, economics, and information technologies due to its high indexing standards and the interdisciplinary nature of the included publications. To ensure the transparency and consistency of the scientific literature selection process, the stages of identification, filtering, and inclusion of studies were structured according to the PRISMA methodological framework adapted to bibliometric analysis, as presented in Figure 1.

The application of the PRISMA methodology within the research is justified by the need to ensure a systematic, transparent, and reproducible process for the identification, selection, and analysis of scientific sources, thereby contributing to increased methodological rigor and reducing the risk of subjectivity in the literature review process, in accordance with the recommendations proposed by David Moher et al. (2009) and updated by Matthew J. Page et al. (2021).

The data collection process was based on the use of a search query formulated to capture the dimensions of organizational and financial resilience, the specific characteristics of IT companies, and the particularities of project-oriented business models. The search formula used is presented in Figure 1. The application of this search query in the Web of Science database initially generated 63

scientific papers covering the period 2006-2026. Subsequently, in order to ensure the relevance and timeliness of the research, the analysis was restricted to the 2015-2026 period, characterized by the intensification of digitalization processes and the development of agile business models within the IT sector. To increase the relevance and scientific coherence of the sample, the selection process was conducted in several stages. In the first stage, only scientific articles and papers published in international conference proceedings were selected, as these contain original research findings and scientifically validated methodological approaches.

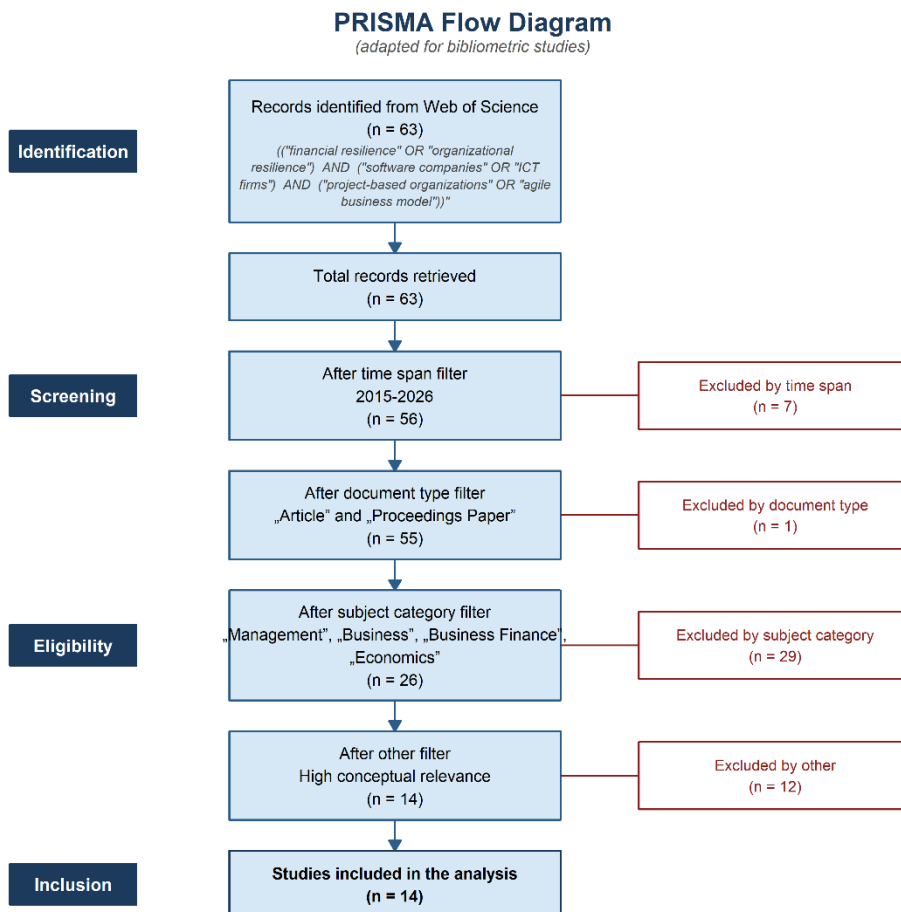


Figure 1. PRISMA diagram of the selection process for scientific papers included in the research

Source: author's processing in the Biblioshiny application (Bibliometrix), based on data extracted from Web of Science

In the next stage, filters related to the thematic categories within Web of Science were applied in order to orient the analysis toward the economic, financial, and managerial dimensions of IT entities' resilience and to exclude studies focused exclusively on technological aspects. Following the PRISMA filtering procedure, a final bibliometric corpus of 26 scientific papers was identified. Subsequently, 14 studies with the highest conceptual relevance to the research objective were selected for the in-depth thematic and comparative analysis, while two additional methodological sources related to the PRISMA framework were included to substantiate the research methodology. Moreover, the selected studies were grouped according to the predominant thematic area: organizational and financial resilience, agile business models, IT project management, financial sustainability, and the adaptive capacity of digital entities.

The applied methodology enabled the development of a coherent research framework focused on identifying dominant trends and existing gaps in the analysis of the relationship between financial resilience and the specific characteristics of business models within the IT industry.

Basic content

The bibliometric analysis conducted using the Biblioshiny tool from the Bibliometrix package enabled the identification of the main thematic directions related to the financial and organizational resilience of project-oriented IT entities. The interpretation of conceptual networks, thematic maps, and keyword co-occurrence relationships facilitated the identification of dominant concepts and emerging trends within the international literature.

Figure 2 presents the conceptual structure of research on the organizational and financial resilience of IT entities by illustrating the relationships among concepts such as "organizational resilience", "dynamic capabilities", "information technology", "firm performance", "digital transformation", and "risk", thereby confirming the interdisciplinary nature of the analyzed field.

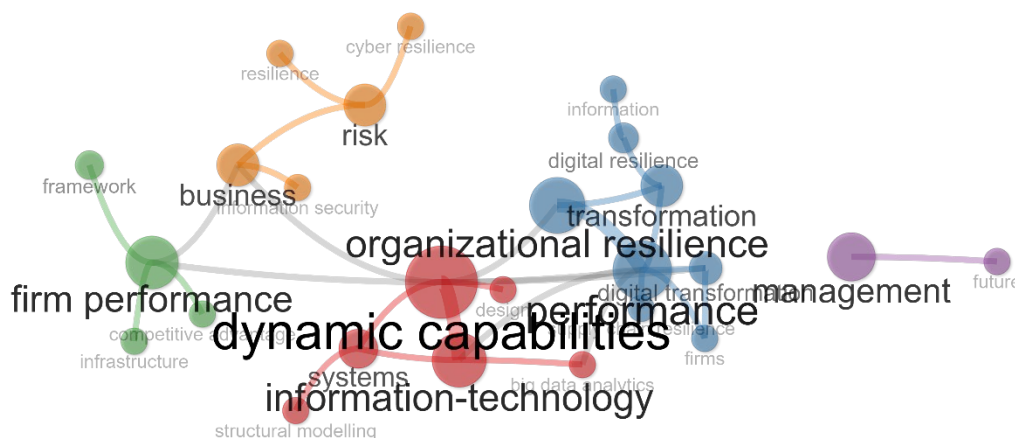


Figure 2. Co-occurrence network of concepts associated with organizational and financial resilience in the IT Sector

Source: author's processing in the Biblioshiny application (Bibliometrix), based on data extracted from Web of Science

A relevant aspect of the analysis is the positioning of the concept "dynamic capabilities" at the center of the conceptual network, suggesting that recent literature considers organizational adaptability as an essential mechanism for maintaining the competitiveness of IT companies in an environment characterized by volatility and uncertainty. Thus, resilience is approached as a result of operational flexibility and the integration of digital technologies into business models. At the same time, the connections between the concepts of "organizational resilience", "digital transformation", and "information technology" reflect the role of digital transformation in strengthening organizational resilience and reducing operational vulnerabilities, particularly within project-oriented companies. Simultaneously, the cluster associated with the concepts of "risk", "business", and "cyber resilience" highlights concerns related to technological and cyber risks, as well as the relationship between organizational resilience, information security, and operational continuity. Furthermore, the relationships among "firm performance", "management", and "digital transformation" demonstrate that organizational performance is also analyzed through companies' ability to integrate digital technologies and agile business models.

The conceptual network analysis also reveals the existence of insufficiently explored directions, particularly regarding the relationship between financial resilience, the accounting and financial specificities of IT entities, and project-oriented business models. Although the literature emphasizes the role of digital transformation and dynamic capabilities, there is limited research integrating the

financial dimension, the volatility of project-based revenues, and the operational flexibility of IT companies simultaneously, which justifies the relevance of the present research.

Figure 3 presents the thematic structure of research on the organizational and financial resilience of IT entities by outlining the main conceptual clusters according to their relevance (centrality) and level of thematic development (density). The thematic map analysis enables the identification of dominant research directions and emerging themes.

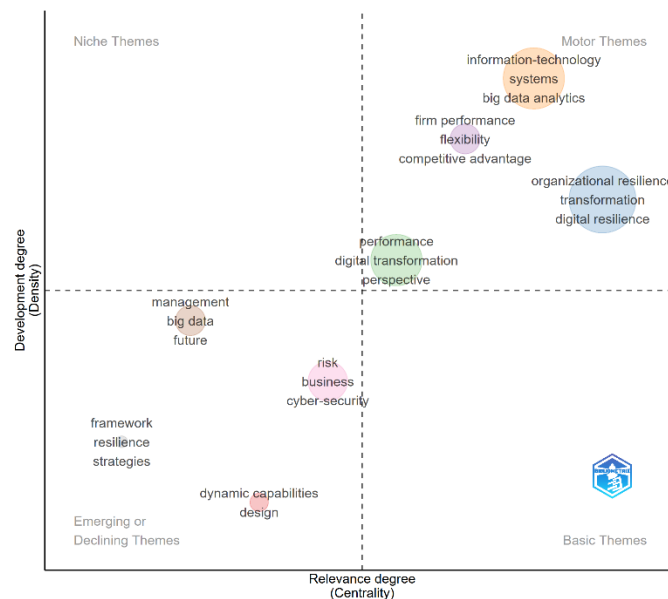


Figure 3. Thematic map of research on organizational resilience and digital transformation in the IT Sector

Source: author's processing in the Biblioshiny application (Bibliometrix), based on data extracted from Web of Science

In the upper-right quadrant, associated with the “Motor Themes,” concepts such as “organizational resilience,” “digital resilience,” “transformation,” “information-technology,” “systems,” and “big data analytics” are identified. Their positioning reflects the attention given to the relationship between digital transformation and the ability of organizations to respond to technological and economic changes. Additionally, the high density of these themes suggests the existence of a well-developed conceptual framework regarding digital resilience and the integration of information technologies into organizational processes.

In the same quadrant, the concepts of “firm performance,” “flexibility,” and “competitive advantage” are also identified, confirming that resilience is analyzed as a determinant of organizational performance and competitiveness, as well as a source of strategic consolidation and long-term sustainability. The central area of the thematic map is dominated by concepts such as “digital transformation,” “performance,” and “perspective,” reflecting the transversal character of digital transformation in current research. Their positioning indicates highly relevant themes that are still undergoing conceptual and methodological development.

In the lower-left quadrant, associated with “Emerging or Declining Themes,” concepts such as “dynamic capabilities,” “framework,” “resilience strategies,” “cyber-security,” “risk,” and “business” are identified. The presence of these concepts highlights the growing interest in the relationship between cyber risks, continuity strategies, and the adaptive capacity of digital organizations, particularly in the context of project-oriented IT companies.

At the same time, the absence of explicitly financial concepts within the central thematic areas reflects the existence of a gap in the specialized literature. Although current studies frequently address digital transformation and organizational resilience, the financial resilience dimension of IT companies

remains insufficiently examined in an integrated manner, which justifies the relevance of the present research.

Based on the bibliometric analysis and the evaluation of the content of the 14 selected studies, the research was structured into five main thematic directions: organizational and financial resilience, agile business models, IT project management, financial sustainability, and the adaptive capacity of digital entities. The analysis results indicate that organizational and financial resilience represents one of the central research directions regarding IT companies and digital transformation. In this context, the selected studies were comparatively synthesized, with emphasis on the research objectives, methodologies used, and the main contributions identified in the analyzed literature.

Table 1. Synthesis of research on the organizational and financial resilience of IT entities

Authors	Research objective	Methodology	Main findings
Gemici, Alpan & Giglio (2024)	Analysis of the influence of technology management capabilities on organizational resilience in ICT companies.	SEM modeling and questionnaire applied to ICT firms in Turkey.	Technological capabilities contribute to increasing resilience and product innovation.
Sincora et al. (2023)	Evaluation of the relationship between process maturity and organizational resilience.	PLS-SEM analysis based on a survey conducted among operational professionals.	Process maturity positively influences adaptive capacity and resilience.
Wu (2021)	Examination of the influence of information costs on business continuity.	Conceptual analysis and evaluation of organizational factors.	Information costs and organizational capacity enhance business continuity.
García-Valenzuela et al. (2023)	Investigation of managerial adaptability in volatile contexts.	Comparative managerial analysis.	Adaptive leadership positively influences resilience.
Gemici, Alpan & Giglio (2024)	Analysis of organizational change and resilience.	Conceptual and managerial analysis.	Organizational change facilitates resilience.

Source: elaborated by the author based on the studies selected from the Web of Science Core Collection

The comparative analysis of the studies presented in Table 1 reveals that the specialized literature approaches organizational resilience through managerial flexibility, operational continuity, and the dynamic capabilities of digital entities. Furthermore, the analyzed studies demonstrate that digital transformation and the integration of information technologies directly influence companies' ability to respond to economic and technological uncertainties. However, the financial dimension of resilience remains insufficiently explored, particularly regarding the implications of project-oriented business models for the sustainability of IT companies. This gap justifies the need for further research on the financial resilience of IT entities. Based on the results obtained through bibliometric analysis and the interpretation of conceptual networks, the adaptive capacity of digital entities was identified as one of the emerging research directions regarding organizational resilience and digital transformation. In this context, the selected studies were comparatively analyzed in order to highlight the factors influencing organizational flexibility and continuity within the IT sector.

The studies summarized in Table 2 indicate that adaptive capacity represents an essential component of organizational resilience in the digital environment. The analyzed studies demonstrate that digital transformation, the development of dynamic capabilities, and the effective use of intellectual capital contribute to increasing organizational flexibility and improving the ability of IT companies to respond to technological and economic changes.

Table 2. Synthesis of research on the adaptive capacity of digital entities

Authors	Research objective	Methodology	Main findings
Zhou, Wang & Zhao (2025)	Analysis of the impact of digital transformation on corporate resilience.	Econometric model based on panel data for Chinese firms.	Digital transformation reduces operational risk and improves resilience.
Li, Li & Ding (2025)	Analysis of the effects of digital transformation on innovation and organizational resilience.	Empirical analysis and statistical modelling.	Digital transformation stimulates innovation and adaptive capacity.
Makhloufi et al. (2024)	Examination of digital ecosystems and resilience.	Information systems analysis.	Digital systems support flexibility and continuity.

Source: elaborated by the author based on the studies selected from the Web of Science Core Collection

Moreover, organizational adaptability is predominantly approached from operational and technological perspectives, while the financial implications of digital transformation remain insufficiently integrated into existing analytical models. In particular, the literature provides a limited number of studies examining the relationship between adaptive capacity and the financial stability of project-oriented IT companies. This gap highlights the need for interdisciplinary approaches that correlate financial resilience with organizational flexibility. The results of the bibliometric analysis indicate that financial sustainability represents a developing research direction, increasingly associated with digital transformation and the adaptive capacity of IT entities. In this context, the selected studies were comparatively analyzed in order to highlight the relationship between digitalization, resilience, and the financial sustainability of technology companies.

The literature synthesized in Table 3 reveals that the financial sustainability of digital entities is influenced by digital transformation, organizational flexibility, and the ability of firms to integrate innovative technologies into operational processes. The analyzed studies demonstrate that digitalization contributes to strengthening economic resilience through the optimization of decision-making processes and the improvement of organizations' ability to respond to external disruptions.

Table 3. Synthesis of research on the financial sustainability of digital entities

Authors	Research objective	Methodology	Main findings
Elnadi et al. (2026)	Analysis of the influence of digital transformation on sustainable performance.	Empirical analysis and statistical modeling.	Digital transformation improves sustainability and organizational flexibility.
Li & Wang (2025)	Investigation of the relationship between digital transformation and industrial chain resilience.	Empirical analysis based on regional data.	Financial support strengthens the relationship between digitalization and resilience.

Source: elaborated by the author based on the studies selected from the Web of Science Core Collection

At the same time, the specialized literature approaches financial sustainability predominantly at a general level, without sufficiently analyzing the specific characteristics of project-oriented IT companies and their dependence on volatile revenues and intangible assets. In particular, there is limited research correlating financial resilience with contractual flexibility and the specific features of agile business models in the software industry. This gap highlights the need to develop integrated models for analyzing financial sustainability in the context of IT entities.

The results of the bibliometric analysis indicate that agile business models represent one of the central research directions regarding the organizational resilience of IT companies. In this context, recent literature emphasizes the role of strategic flexibility, digital transformation, and market orientation in strengthening organizations' ability to respond to economic and technological changes. To further

explore this direction, the selected studies were comparatively analyzed from the perspective of research objectives, methodologies used, and the main findings obtained.

The comparative analysis of the studies presented in Table 4 reveals that agile business models contribute to the development of organizational resilience by increasing strategic flexibility and improving the ability to adapt to changes in the external environment. The analyzed studies demonstrate that digital transformation, market orientation, and the development of organizational relationships represent important factors for strengthening the competitiveness and continuity of IT companies.

Table 4. Synthesis of research on agile business models and organizational resilience

Authors	Research objective	Methodology	Main findings
Zhang, Li & Zhao (2025)	Analysis of the impact of digital transformation on organizational resilience and agile response.	Empirical analysis and statistical modelling.	Digital transformation and innovation capability strengthen resilience and organizational flexibility.
Mehmood et al. (2025)	Evaluation of innovation management and resilience.	Managerial and empirical analysis.	Strategic innovation contributes to organizational stability.

Source: elaborated by the author based on the studies selected from the Web of Science Core Collection

Simultaneously, the existing literature approaches agile business models predominantly from managerial and operational perspectives, without sufficiently analyzing the financial implications of project-oriented activities. In particular, there is limited research regarding the influence of revenue fluctuations and project dependency on the financial resilience of IT entities. This gap highlights the need for integrated approaches that correlate agile business models with the financial sustainability of digital companies.

The bibliometric analysis indicates that IT project management represents one of the relevant research directions regarding organizational resilience and the adaptive capacity of digital companies. The specialized literature emphasizes the role of technological strategies and managerial capabilities in strengthening organizational flexibility and managing the risks specific to project-oriented activities. In this context, the selected studies were comparatively analyzed from the perspective of research objectives, methodologies used, and the main findings obtained.

The comparative analysis of the studies presented in Table 5 indicates that IT project management influences the development of organizational resilience through the strengthening of managerial capabilities, the integration of technological strategies, and the stimulation of innovative processes. The analyzed studies demonstrate that the flexibility of project processes and the use of digital technologies contribute to improving organizations' responses to operational risks and changes in the economic environment.

Table 5. Synthesis of research on IT project management and organizational resilience

Authors	Research objective	Methodology	Main findings
Tello-Gamarra, J., Mayorga Gutierrez, D. J., Hernani-Merino, M., Zevallos, J. (2024)	Examination of the relationship between technological intensity and innovation capability in firms operating in an emerging economy.	Statistical modeling and managerial analysis.	Greater technological intensity enhances innovation capability and strengthens firms' competitive positioning.
Coiciu & Militaru (2024)	Analysis of the implementation of digital business continuity systems and cyber resilience.	Conceptual analysis and applied study.	Digital continuity systems enhance organizational resilience and risk response capacity.

Source: elaborated by the author based on the studies selected from the Web of Science Core Collection

Therefore, the existing literature approaches IT project management predominantly from operational and strategic perspectives, without sufficiently integrating the financial dimension of project-based activities. In particular, there is limited research regarding the influence of project revenue fluctuations and contractual dependency on the financial resilience of IT companies. This gap justifies the need to develop integrated approaches that correlate IT project management with the financial sustainability and organizational stability of digital entities.

Conclusions

The conducted bibliometric and conceptual analysis reveals that the resilience of IT companies should be approached as an integrated mechanism combining financial flexibility, adaptive capacity, digital transformation, and the specific characteristics of project-oriented business models. The analyzed studies demonstrate that the development of dynamic capabilities, the integration of information technologies, and the use of agile models contribute to strengthening the stability and competitiveness of digital organizations. Additionally, the obtained results confirm the existence of gaps in the specialized literature. Although numerous studies examine organizational resilience, digital transformation, or IT project management, the financial resilience dimension remains insufficiently integrated into research on project-oriented companies. In particular, there is limited research correlating revenue volatility, contractual dependency, and operational flexibility with the financial sustainability of IT entities.

In this context, the author's contribution consists in developing an integrated approach to the financial resilience of IT entities by correlating organizational, technological, and financial dimensions within a unified conceptual framework. The originality of the research lies in the delimitation and systematization of the five dominant thematic directions identified in the international literature, as well as in highlighting the interdependencies among them. Furthermore, the research contributes to expanding the perspective on IT companies by integrating the specific characteristics of project-based activities into the analysis of financial resilience, emphasizing the role of revenue fluctuations, contractual flexibility, and intellectual capital in maintaining the economic stability of digital entities. Another contribution of the research is the use of bibliometric analysis and visual conceptual interpretation tools for identifying dominant trends and existing gaps in the international literature. Through the use of thematic maps, co-occurrence networks, and the PRISMA procedure adapted to bibliometric analysis, the study provides a structured overview of the evolution of the research field. Overall, the findings suggest that financial resilience may represent an important condition for the sustainability and competitiveness of digital organizations in the context of accelerating technological transformation and increasing economic uncertainties.

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SECTION 6: BUSINESS INFORMATICS

UNDERSTANDING INVESTMENT RISK UNDER UNCERTAINTY: A THEORETICAL EXPLORATION IN THE CONTEXT OF ROMANIA AND THE REPUBLIC OF MOLDOVA

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Abstract: *This article explores the concept of uncertainty as a defining dimension of investment risk in Romania and the Republic of Moldova. The study was motivated by the increasing limitations of traditional financial theories that primarily interpret investment risk through measurable statistical indicators, despite the growing complexity of contemporary economic and geopolitical environments. Emerging and transition economies are increasingly exposed to structural instability, institutional fragility, geopolitical tensions, technological transformation, and behavioral volatility, which generate forms of uncertainty that cannot be fully captured through conventional probabilistic models. The paper adopts an interdisciplinary theoretical approach integrating perspectives from financial economics, institutional theory, behavioral finance, complexity economics, and cybernetics. The analysis focuses on conceptualizing uncertainty and examining its principal dimensions within Romania and the Republic of Moldova, including macroeconomic, institutional, geopolitical, behavioral, and technological uncertainty. Attention is given to the structural characteristics of Eastern European transition economies and the ways in which uncertainty influences investor behavior, financial stability, and economic resilience. The findings suggest that uncertainty should be understood not as a temporary disturbance, but as a permanent structural feature of contemporary financial systems. In both Romania and the Republic of Moldova, investment environments are shaped by interconnected economic, political, institutional, and geopolitical factors that alter expectations and market dynamics. The study highlights that adaptive and cybernetic approaches provide more suitable theoretical frameworks for understanding modern financial systems than static equilibrium-based models. Ultimately, the article argues that resilience, adaptability, and institutional flexibility are becoming increasingly important for investment decision-making under conditions of persistent uncertainty.*

Key words: *uncertainty; investment risk; emerging markets; geopolitical instability; adaptive systems; Romania and Republic of Moldova.*

JEL: D81, D84, G11, G32, O16, P52

Introduction

Uncertainty has become one of the defining characteristics of contemporary economic and financial systems. While classical financial theory traditionally focuses on measurable risk, modern economic realities increasingly demonstrate that investors operate in environments where future events cannot be fully predicted, quantified, or modeled through stable probabilistic distributions. This distinction is particularly relevant in emerging and transition economies, where institutional instability,

geopolitical tensions, structural vulnerabilities, and asymmetric information significantly shape investment behavior and market dynamics.

Romania and the Republic of Moldova represent two interconnected yet structurally different economic spaces in Eastern Europe, both characterized by varying degrees of uncertainty. Romania, as a member of the European Union and an emerging financial market, has undergone significant institutional and economic transformation during the past decades. Nevertheless, the Romanian economy remains exposed to inflationary fluctuations, fiscal instability, external dependency, labor migration, political polarization, and global financial volatility. In contrast, the Republic of Moldova faces deeper structural uncertainty generated by institutional fragility, geopolitical pressure, energy dependency, limited financial market development, and high economic sensitivity to external shocks. In this context, uncertainty should not be understood merely as a temporary disturbance affecting investment decisions. Rather, uncertainty constitutes a structural characteristic of economic and financial systems in transition economies. Unlike measurable risk, uncertainty reflects situations in which future outcomes, probabilities, or causal relationships remain fundamentally incomplete, ambiguous, or unstable. Knight [1] distinguished between risk, where probabilities are known, and uncertainty, where future events cannot be objectively quantified. This distinction remains highly relevant for understanding investment environments in Romania and the Republic of Moldova.

The increasing complexity of global financial systems further amplifies uncertainty. Economic crises, pandemics, geopolitical conflicts, technological disruption, climate-related challenges, and energy market instability continuously reshape investor expectations and financial behavior. Under such conditions, deterministic models based solely on historical data become insufficient for explaining financial dynamics. Instead, uncertainty emerges as a multidimensional phenomenon involving economic, political, institutional, behavioral, technological, and geopolitical dimensions.

Theoretical approaches to uncertainty have evolved considerably within economics and finance. Keynes [2] emphasized the instability of expectations and the impossibility of fully predicting future economic conditions. More recent perspectives derived from behavioral economics, institutional economics, complexity theory, and cybernetics suggest that financial systems should be interpreted as adaptive and evolving structures characterized by feedback mechanisms, non-linearity, and imperfect information.

For Romania and the Republic of Moldova, uncertainty has both internal and external determinants. Internally, uncertainty is influenced by institutional quality, governance effectiveness, macroeconomic consistency, financial market maturity, and social trust. Externally, uncertainty is amplified by regional geopolitical instability, global economic integration, energy dependency, and international capital market fluctuations. Consequently, investment risk in these economies cannot be analyzed exclusively through conventional statistical indicators such as volatility or variance. Instead, uncertainty itself becomes a central analytical category.

This article aims to develop a theoretical understanding of uncertainty in the context of investment risk within Romania and the Republic of Moldova. The study focuses primarily on conceptualizing uncertainty, identifying its main dimensions, and examining its implications for investment behavior and financial decision-making in emerging and transition economies. The paper adopts an interdisciplinary perspective integrating financial theory, institutional analysis, behavioral economics, and adaptive systems thinking. The article is structured into three sections. Following the introduction, the second section examines the theoretical foundations of uncertainty, its manifestations within Romania and the Republic of Moldova, and the relationship between uncertainty and investment behavior. The final section presents the conclusions and discusses the broader implications of uncertainty-oriented approaches for financial research and economic policy.

Basic content

Defining Uncertainty in Financial and Economic Theory

The concept of uncertainty occupies a central position in economic thought. Although frequently associated with risk, uncertainty represents a distinct theoretical category. In financial theory, risk generally refers to measurable variability associated with future outcomes, often expressed through probabilistic distributions, volatility indicators, or statistical models [3]. Uncertainty, however, describes situations where future outcomes cannot be fully predicted, probabilities remain unknown, or causal relationships are unstable and incomplete.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2} \quad (1)$$

The standard deviation formula above illustrates how traditional finance measures measurable risk through dispersion around an expected mean. However, uncertainty extends beyond measurable dispersion because future structures themselves may change unpredictably. Frank Knight [1] introduced one of the most influential distinctions between risk and uncertainty. According to Knight, risk refers to situations in which probabilities can be estimated, whereas uncertainty involves fundamentally unknown outcomes that cannot be statistically calculated. In emerging economies, uncertainty often dominates because institutional and macroeconomic environments evolve continuously and unpredictably. Keynes [2] further expanded this perspective by emphasizing the fragility of expectations. Economic actors make decisions under incomplete knowledge about the future, relying not only on rational calculations but also on conventions, subjective beliefs, and confidence. Under uncertainty, investment decisions become highly sensitive to changing perceptions and emotional reactions.

Within Romania and the Republic of Moldova, uncertainty should therefore be understood as a structural condition rather than an exceptional event. Financial and economic systems in both countries are influenced by ongoing institutional adaptation, external dependencies, and geopolitical transformations that reduce predictability and increase informational instability. Uncertainty in these economies can be theoretically classified into several interconnected dimensions: macroeconomic uncertainty; institutional uncertainty; geopolitical uncertainty; financial market uncertainty; technological uncertainty; behavioural uncertainty; regulatory uncertainty. These dimensions interact dynamically and collectively shape investment environments.

Macroeconomic Uncertainty in Romania and the Republic of Moldova

Macroeconomic uncertainty refers to instability associated with inflation, interest rates, exchange rates, fiscal policies, economic growth, and labor market conditions. In emerging economies, macroeconomic fluctuations are generally more pronounced due to weaker institutional stabilization mechanisms and higher exposure to external shocks [4].

Romania has experienced substantial economic growth following European integration; however, its economy remains vulnerable to inflationary pressures, fiscal imbalances, and external market fluctuations. Periods of high inflation and monetary tightening increase uncertainty regarding future consumption, borrowing costs, and investment profitability. Exchange-rate fluctuations further complicate investment decisions, particularly for foreign investors and internationally exposed sectors. The Republic of Moldova experiences even higher levels of macroeconomic uncertainty. Economic dependency on remittances, imported energy, and agricultural production increases vulnerability to external disturbances. Energy crises and geopolitical instability in Eastern Europe significantly affect inflation dynamics, currency stability, and economic expectations [5].

Under such conditions, investment decisions cannot rely exclusively on historical market performance because future macroeconomic trajectories remain uncertain. Investors operating in Romania and Moldova must continuously adapt to changing economic environments characterized by incomplete information and structural instability.

Institutional Uncertainty and Governance Fragility

Institutional uncertainty represents one of the defining characteristics of transition economies. Institutions reduce uncertainty by establishing stable rules, predictable regulations, legal protections, and governance structures [6]. When institutional quality is weak or inconsistent, investors face difficulties in estimating future conditions and assessing long-term investment security.

Romania has achieved important institutional improvements through European integration and regulatory harmonization. Nevertheless, investors continue to perceive uncertainty associated with political instability, bureaucratic inefficiency, fiscal unpredictability, and governance inconsistencies [7]. Frequent legislative modifications and political tensions contribute to reduced predictability in economic decision-making. In the Republic of Moldova, institutional uncertainty is more pronounced. Weak governance structures, corruption perceptions, lower regulatory capacity, and political instability generate significant uncertainty premiums for investors [8]. Consequently, long-term investment projects face higher perceived risks due to uncertain institutional continuity and policy implementation.

Institutional uncertainty influences not only foreign investment flows but also domestic entrepreneurial behavior. When economic actors lack confidence in institutional stability, investment horizons shorten, speculative behavior increases, and long-term economic planning becomes more difficult. From a theoretical perspective, institutional fragility amplifies other forms of uncertainty by weakening society's capacity to absorb shocks and coordinate expectations. Consequently, institutional resilience becomes essential for reducing uncertainty within emerging financial systems.

Geopolitical Uncertainty and Regional Instability

Geopolitical uncertainty has become one of the most influential determinants of economic and financial instability within Eastern Europe. Unlike conventional macroeconomic fluctuations, geopolitical uncertainty originates from political conflicts, strategic rivalries, military tensions, diplomatic fragmentation, sanctions regimes, territorial disputes, and energy-security vulnerabilities. Such forms of uncertainty are particularly difficult to quantify because they evolve rapidly, involve multiple actors, and frequently generate unpredictable economic consequences across interconnected financial systems [9,10]. For emerging and transition economies, geopolitical instability creates structural uncertainty that extends beyond temporary market reactions. Investors operating within uncertain geopolitical environments must evaluate not only economic indicators, but also political alignments, regional security dynamics, international strategic interests, and the possibility of sudden institutional or regulatory change. Consequently, geopolitical uncertainty transforms investment decision-making into a multidimensional process in which financial calculations are inseparable from broader political and strategic considerations [11,12].

Romania occupies a strategically important geopolitical position at the eastern border of the European Union and NATO. This position simultaneously generates opportunities and vulnerabilities. On one hand, Romania benefits from security guarantees, institutional integration, access to European markets, and increased credibility among international investors due to its membership within Western political and economic structures. These factors contribute to institutional stability and strengthen long-term investment confidence. On the other hand, Romania's geographical proximity to regional conflicts and geopolitical tensions exposes the country to indirect economic risks associated with military instability, migration pressures, energy insecurity, and fluctuations in regional investor sentiment [9,13]. The geopolitical significance of the Black Sea region further amplifies uncertainty within Romania's investment environment. The Black Sea has increasingly become a strategic space characterized by competition over energy resources, transport corridors, military influence, and regional security architecture. Any instability affecting this region may influence investor confidence, international trade routes, infrastructure projects, and financial market expectations. Under such conditions, geopolitical developments become economically relevant even when direct economic damage remains limited [14].

For the Republic of Moldova, geopolitical uncertainty represents an even more fundamental structural condition. Moldova's geopolitical position between the European Union and the post-Soviet sphere of influence creates continuous strategic ambiguity regarding economic orientation, institutional development, and long-term political stability. This ambiguity contributes to uncertainty concerning future regulatory frameworks, international partnerships, and economic integration processes [15]. Moldova's dependence on imported energy resources further intensifies geopolitical vulnerability. Energy dependency transforms geopolitical tensions into direct economic risks capable of affecting inflation, industrial production, household consumption, fiscal stability, and overall investor confidence. Under conditions of geopolitical instability, energy prices may fluctuate rapidly, creating uncertainty regarding production costs, economic growth prospects, and financial sustainability [16]. Moreover, geopolitical uncertainty influences investor behavior not only through objective economic consequences, but also through subjective perceptions of regional instability. Investors frequently respond to anticipated risks rather than exclusively to realized events. Consequently, geopolitical narratives, diplomatic tensions, military rhetoric, and media representations may significantly influence financial expectations and capital allocation decisions even before measurable economic impacts emerge [17]. In emerging economies such as Romania and the Republic of Moldova, geopolitical uncertainty also interacts with institutional fragility and market vulnerability. Financial markets characterized by lower liquidity and reduced depth tend to react more strongly to external shocks and changes in international sentiment. As a result, geopolitical events may generate disproportionate market volatility, exchange-rate fluctuations, and capital outflows relative to the scale of the initial disturbance [18]. Geopolitical instability additionally affects foreign direct investment decisions. Long-term investors generally prioritize predictability, institutional continuity, and strategic stability when evaluating investment destinations. Persistent geopolitical uncertainty increases perceived country risk and may discourage investments requiring long planning horizons, substantial infrastructure commitments, or exposure to regional supply chains. In this context, uncertainty itself becomes economically costly because it reduces strategic confidence and weakens long-term development perspectives [11,19].

Another important dimension of geopolitical uncertainty concerns the fragmentation of globalization and the increasing regionalization of economic systems. Contemporary geopolitical tensions have accelerated the restructuring of supply chains, energy partnerships, technological cooperation, and strategic industries. Such transformations create new forms of uncertainty for emerging economies integrated into international markets. Romania and Moldova must therefore continuously adapt to changing geopolitical and economic configurations that reshape trade flows, investment priorities, and strategic partnerships [20]. The psychological dimension of geopolitical uncertainty should also be emphasized. In periods characterized by regional instability, collective perceptions of insecurity tend to intensify risk aversion among both investors and consumers. Financial decision-making becomes increasingly influenced by precautionary behavior, defensive strategies, and expectations of future instability. Consequently, geopolitical uncertainty may contribute to reduced investment activity, lower entrepreneurial confidence, and increased financial conservatism even in the absence of immediate economic deterioration [21,22]. From a theoretical perspective, geopolitical uncertainty demonstrates that financial systems cannot be analyzed independently from broader political and strategic structures. Economic systems are deeply embedded within geopolitical environments that continuously shape institutional development, investor expectations, and financial stability. In emerging and transition economies, where institutional resilience remains comparatively weaker, geopolitical instability often amplifies existing economic vulnerabilities and generates complex forms of interconnected uncertainty [23,24].

Behavioural Uncertainty and Investor Psychology

Behavioral economics highlights the importance of psychological and emotional factors in financial decision-making under uncertainty. Investors do not behave as perfectly rational actors; instead, they

rely on heuristics, subjective perceptions, and emotional reactions [25]. Under uncertain conditions, cognitive biases become increasingly influential. Loss aversion, herding behavior, overconfidence, and panic reactions significantly shape market dynamics, particularly within emerging economies characterized by lower informational transparency and higher volatility.

$$U(x) = \begin{cases} x^\alpha, & x \geq 0 \\ -\lambda(-x)^\beta, & x < 0 \end{cases} \quad (2)$$

The Prospect Theory value function above illustrates how investors perceive losses more intensely than equivalent gains, reinforcing risk aversion during uncertain periods. In Romania and the Republic of Moldova, behavioral uncertainty is amplified by historical experiences of economic instability, inflationary episodes, and institutional distrust. Investor expectations are therefore shaped not only by objective indicators but also by collective memory, political narratives, and social perceptions. Media influence and digital communication further intensify uncertainty. Information spreads rapidly across digital platforms, often amplifying emotional reactions and speculative behavior. Under uncertain conditions, market sentiment may become as influential as economic fundamentals themselves [26]. Behavioral uncertainty demonstrates that financial instability is not purely objective. Rather, uncertainty is socially and psychologically constructed through expectations, narratives, and collective perceptions.

Adaptive Systems and the Cybernetic Perspective of Uncertainty

Traditional financial models frequently assume equilibrium, rational expectations, and relatively stable relationships among economic variables. Classical financial theories are generally constructed upon the premise that markets tend toward efficiency and that future outcomes can be estimated through historical data and probabilistic reasoning. However, contemporary economic and financial environments increasingly challenge these assumptions. Global financial crises, geopolitical instability, pandemics, technological disruptions, and energy shocks demonstrate that financial systems often behave in non-linear and unpredictable ways. Under such conditions, uncertainty cannot be treated merely as a temporary anomaly affecting otherwise stable systems. Instead, uncertainty becomes a structural characteristic of modern economic environments [23,24]. Within this context, adaptive and cybernetic approaches provide important theoretical alternatives for understanding financial systems operating under uncertainty. Cybernetic theory focuses on communication, feedback mechanisms, learning processes, adaptation, and self-regulation within complex systems [24]. Unlike static equilibrium-based models, cybernetic approaches interpret economic systems as continuously evolving structures capable of responding dynamically to internal and external disturbances.

In financial contexts, cybernetic principles can be applied to investment behavior and market dynamics. Investors continuously observe new information, estimate uncertainty, formulate expectations, make decisions, evaluate outcomes, and subsequently modify future strategies. This process creates adaptive feedback loops in which learning and adjustment become essential components of financial decision-making. Consequently, financial markets function not as perfectly balanced equilibrium systems, but rather as evolving adaptive networks characterized by interaction, feedback, and continuous transformation [23,27]. Adaptive systems theory further suggests that economic systems possess emergent properties that cannot be fully explained through isolated variables or linear causal relationships. Small disturbances may generate disproportionately large consequences due to interconnectedness and feedback amplification mechanisms. This perspective became particularly relevant following the global financial crisis of 2008, which demonstrated how interconnected financial systems can rapidly transmit instability across international markets [28].

Romania and the Republic of Moldova can both be interpreted as adaptive economic systems exposed to continuous structural transformation. Romania's integration into the European Union, financial modernization, digitalization processes, demographic changes, and institutional reforms have continuously reshaped the country's economic structure during recent decades. Simultaneously,

Romania remains exposed to inflationary pressures, fiscal instability, labor migration, and regional geopolitical tensions, all of which contribute to persistent uncertainty within financial and investment environments. The Republic of Moldova experiences even more pronounced adaptive pressures due to its geopolitical positioning, institutional fragility, energy dependency, and economic vulnerability. Moldova's economic and financial systems must constantly adjust to changing external conditions, including regional conflicts, fluctuating energy markets, migration dynamics, and evolving international partnerships. Consequently, adaptation itself becomes a central characteristic of economic survival and financial resilience. Adaptive approaches emphasize resilience rather than deterministic prediction. Traditional financial models frequently attempt to reduce uncertainty by improving forecasting precision and statistical estimation. However, adaptive theories argue that complete prediction is impossible in highly complex and evolving systems [29]. Instead of assuming full control over future outcomes, adaptive systems seek flexibility, responsiveness, learning capacity, and resilience under changing conditions.

This perspective is increasingly relevant because uncertainty within global financial systems has become continuous rather than episodic. Contemporary economies are affected simultaneously by multiple interconnected risks, including geopolitical instability, technological disruption, climate-related pressures, cybersecurity threats, and global financial contagion. Under such conditions, economic systems must continuously adapt to evolving environments rather than merely return to previous equilibrium states. The increasing use of artificial intelligence and machine learning in financial analysis reflects this transition toward adaptive decision systems [30]. Machine learning models are capable of identifying hidden patterns, processing large quantities of information, and adjusting predictions dynamically as new data emerge. Such technologies are increasingly utilized in portfolio optimization, algorithmic trading, risk management, fraud detection, and macroeconomic forecasting. From a theoretical perspective, artificial intelligence represents an attempt to enhance adaptability within financial systems. Unlike traditional econometric models based on fixed assumptions and linear relationships, machine learning approaches may continuously update internal structures in response to changing data environments. This adaptive capacity makes artificial intelligence particularly attractive for financial environments characterized by uncertainty and non-stationarity [31]. Technological sophistication cannot eliminate uncertainty entirely. Machine learning systems remain dependent on data quality, historical information, and algorithmic assumptions. Structural breaks, unprecedented events, geopolitical crises, and sudden institutional changes may significantly reduce predictive accuracy. Financial crises frequently emerge precisely because historical relationships become unstable or because unexpected events fundamentally alter economic behavior [32].

Moreover, artificial intelligence itself may introduce additional forms of uncertainty into financial systems. Algorithmic trading, automated investment strategies, and interconnected digital financial infrastructures may increase systemic complexity and amplify market instability during periods of stress. Highly interconnected computational systems can accelerate contagion effects, informational cascades, and rapid market reactions [33]. Behavioral uncertainty further limits the capacity of adaptive technologies to fully predict financial outcomes. Investor psychology, collective expectations, emotional reactions, and political perceptions cannot always be adequately captured through quantitative models. Human decision-making under uncertainty frequently deviates from rational or statistically predictable behavior, particularly during periods of crisis or instability [21,22]. Another important dimension of adaptive systems concerns institutional learning. Economic resilience depends not only on technological adaptation, but also on institutional flexibility and governance capacity. Romania and the Republic of Moldova continuously face the challenge of adapting regulatory frameworks, financial institutions, and economic policies to rapidly changing international environments. Institutional rigidity may amplify uncertainty, whereas adaptive governance structures may improve resilience and reduce systemic vulnerability [25,34]. Adaptive

and cybernetic perspectives therefore provide a broader understanding of uncertainty within modern financial systems. Rather than treating uncertainty as a deviation from equilibrium, these approaches recognize uncertainty as an intrinsic and permanent feature of evolving economic environments. Financial systems are not static mechanisms governed exclusively by predictable laws, but dynamic structures shaped by feedback, interaction, learning, institutional transformation, and behavioral complexity. Consequently, investment decision-making within Romania and the Republic of Moldova increasingly requires adaptive frameworks capable of integrating economic, geopolitical, institutional, technological, and behavioral dimensions of uncertainty. Under contemporary conditions, resilience, flexibility, and continuous learning may become more important than deterministic forecasting accuracy itself.

Conclusions

This article examined uncertainty as a central concept for understanding investment risk in Romania and the Republic of Moldova. Unlike traditional approaches focused exclusively on measurable risk, the study emphasized that uncertainty represents a broader and more complex phenomenon involving incomplete information, institutional instability, behavioral dynamics, and geopolitical unpredictability.

In the context of Romania and the Republic of Moldova, uncertainty should be understood as a structural characteristic of economic and financial systems rather than a temporary disturbance. Both countries operate within environments shaped by macroeconomic volatility, institutional transformation, external dependency, and regional geopolitical instability. Consequently, investment decisions are strongly influenced by factors that cannot be fully captured through conventional probabilistic models. The analysis highlighted multiple dimensions of uncertainty, including macroeconomic, institutional, geopolitical, behavioral, and technological uncertainty. These dimensions interact continuously and collectively influence investor expectations, market confidence, and financial stability.

Behavioral and institutional perspectives demonstrated that uncertainty is not purely objective. Investor psychology, social perceptions, institutional trust, and political narratives significantly shape financial behavior and market outcomes [35]. Similarly, geopolitical developments increasingly influence investment dynamics within Eastern Europe. The article also emphasized the relevance of adaptive and cybernetic perspectives for understanding uncertainty in modern financial systems. Contemporary economies function as complex adaptive systems characterized by feedback loops, non-linearity, and continuous transformation. Under such conditions, resilience, flexibility, and learning become more important than deterministic prediction.

Ultimately, uncertainty should not be treated merely as an obstacle to financial analysis, but as a defining structural feature of contemporary investment environments. Future research concerning Romania and the Republic of Moldova should continue developing interdisciplinary approaches capable of integrating economic, institutional, behavioral, technological, and geopolitical dimensions of uncertainty.

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AI-POWERED SOLUTIONS AND THEIR APPLICATIONS IN IT PROJECT MANAGEMENT

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Abstract: *Project managers professions have the possibility nowadays to use new tools developed and powered by AI that enhance their work and make it more efficient. This paper explores how artificial intelligence AI driven solutions are used in project management applying a qualitative approach based on the PMBOK as a guideline. The methodology structures activities on different focus areas that are mapped to different AI tools based on capability. This analysis highlights on how solutions that are using AI available on the market help professionals in this domain, considering various activities, such as document analysis, cost estimation, work tracking or risk management. These AI tools have the possibility to enhance the efficiency of a project manner on their projects. This study provides practical insights into how AI can be applied within real-world projects across organizations considering AI tools available today. It also emphasizes the growing utilization of artificial intelligence across various industries, with an impact on expanding role in project management.*

Key words: *project management, artificial intelligence, AI tools and applications, AI-powered solutions*

JEL: M11, O22

Introduction

There are many studies in academic literature on analyzing the impact of AI utilization on project management and at the same time, there is a very fast evolution in the world of AI releases in general that can become hard to follow and be up to date, as there are multiple companies in competitions that are doing the releases. For instance, there are big companies, meaning Open AI - Chat GPT (Generative Pre-trained Transformer), Meta- LLaMA (Large Language Model Meta AI), Anthropic -Claude, Microsoft – Copilot, Google-Gemini and many more. These companies are doing frequent releases with new models that have enhanced capabilities. Currently the latest model from Open AI, GPT -5.5 (OpenAI, 2026), has improved capabilities compared to previous model GPT 5.4, at generating documents, spreadsheets, and slide presentation. On their websites, are presented tools capabilities, in comparison with older models, but also with other companies, such as Claude Opus 4.7 or Gemini 3.1 Pro (OpenAI, 2026). On the other hand, Anthropic, announced their release of Claude Opus 4.7 in April 2026, with a focus on coding and complex multi-step tasks (Anthropic, 2026). In order to keep up with the pace, these companies offer online presentations, or podcast to present the capabilities and how it can be used.

In a survey done by MIT Sloan Management Review and Boston Consulting Group on 2102 respondents from 21 industries and 116 countries, highlighted that the adoption of traditional AI increased to 72% in 2025 (percentage of organization including AI in their work). The survey also showed that respondents believe AI will become more an assistant, coach or mentor (MIT Sloan

Management Review, 2025). A different study from Accenture (2026) in pulse of change report, survey applied on over 3000 C-suite executives across 20 industries and 20 countries highlighted that the biggest obstacle to AI success is no longer the technology itself, but ensuring the alignment with the employee.

These releases of AI have an impact also in project management fields, that could help professionals with issues that usually arise, such as wrong estimation or budget overrun. Dacre and Kockum (2022) highlighted in their study that AI will redefine the project professional responsibilities and it also pointed out that the most widely is applied during planification phase.

Traditional project managers use workflow manually and could run into difficulties in analysing large amount of data, or keep the documentation up to date, or do updates manually. AI tools are created to save time and reduce human error, as emphasised by Microsoft (n.d.).

This article explores what type of AI exists, and how to use it to increase efficiency and optimization and give insights on how can these methods and tools be integrated in daily practice of professionals.

Theoretical background

There is a growing number of publications in the academic literature in the latest years. According to Vergara et al. (2025) in their study of publications for artificial intelligence in project management, and their analysis for publications from 2019 until 2024, it showed an annual growth of 70,32%. The same authors pointed out that the top countries considering the contribution to academic literature are United States, China and followed by India.

Serikbay et al. (2025) discussed in their study based on a survey for specific regions, about the AI adoption level in managing projects on different levels across the eight performance domains. Specific in their study, it was observed that the most often used AI is in planning phase and also team related activities and, at the same time, is much less used in the area where soft skills are needed, such as stakeholder management.

Another analysis presented by Ruiz et al. (2026) is the rising adoption of large language models that aim to automate tasks, such as resource distribution or prediction performance. Adamantiadou and Tsironis (2025) studied the use of AI, considering cost estimation, duration forecasting and risk assessment, but also noted that a numerous studies from the academic literature lack empirical validation.

According to Vergara et al. (2025) there are different methods and techniques that can help project managers in different focus area of their activities, such as predictive analytics, machine learning, natural language processing or pattern recognition techniques (Adamantiadou and Tsironis, 2025).

Machine learning allows computers to learn from data without explicit instruction to do it, according to Brown (2021). For instance, Mahdiet et al. (2021) explored the utilization of machine learning in project management and presented advantages, such as risk detection and cost estimation. On the other hand, natural language processing is the ability to understand and generate human language (Erickson, 2025). It transforms input into a format that machines can understand, enable communication across multiple languages and is commonly used by chatbots (Mohana, 2024). Di Giuda et al. (2020) highlighted in their study that it should also be used in early stages in project management, when creating the requirements.

There are different developments based on AI that could be used by project managers and improve their work, such as AI agents, AI assistants or bots. Cinkusz et al. (2025) studied the cognitive agents that replicate different agile roles, generate artefacts and help maintain performance in check. According to Google (2025) AI agents are good at doing tasks with a certain level of autonomy on behalf of a user, and have the capacity to learn and adapt. There are multiple types of agents, and can be classified in different ways. Anjelia et al. (2025) classified in their study the AI Agent types into conversational AI, multi-agent and specific to domain agents. Viswanathan et al. (2025) concluded that agents are changing how automation and problem solving is done in different industries. Unlike

AI agents that can take decisions and be more proactive withing a defined set of rules, an AI assistant is responding to requests (Google, 2025).

Methodology

This study adopts a qualitative approach to explore the applicability of AI powered solutions in project management. The methodology framework is based on PMBOK (Project Management Body of Knowledge) Guide (2025), 8th edition. This paper presents an exploratory analysis on how artificial intelligence tools and platforms impact project management activities on specific focus areas. The proposed conceptual framework is focused on emerging trends in AI adoption that exists on the market and is categorized by the focus area as it is defined in PMBOK, which is a standard in project management acknowledged worldwide (PMI, 2025). PMBOK Guide explains all types of management, from traditional, agile or using artificial intelligence and it is based on sever performance domains.

This methodology consists in separating different project management activities, such as project charter, requirement analysis, resource allocation, cost estimation, risk management, workflow tracking, or project documentation, allocate them to the specific project focus area, as it is defined in PMBOK guide. For each specified activity, there is an example of a tool that can be used in practice. The criteria for selecting the tools is based on be eligible for project management and to include artificial intelligence. All selected activities are mapped with capabilities of the related proposed tools.

Results

Artificial intelligence applications are used in different domains and zones and professionals need to adapt very fast in order to keep up with the continuous changes that arise and can help or optimize the work (PMBOK, 2025).

The results of this study emphasis on the growing numbers of AI tools that are developed for professional project managers and can be used in different areas. The AI assistants can help professionals to manage efficiently the work and track the progress (IBM, 2025).

On the market there are developed different tools, based on the process that it is needed to be supported, from initiations to closure of the project. Therefore, these instruments can be classified based on the process that it is supporting, automatizing or optimizing.

These tools are specifically created to help the professionals and increase efficiency. In the near past, the project managers had to do some manual activities that were time consuming. For instance, minutes of meetings were part of a usual activity a professional in domain would do. For this to happen, the project manager should have attended the meeting, paying attention to each topic, take notes and after the meeting to arrange them and write it in a format easy to read, and send it to all participants. Nowadays, using an AI tools, the project manager does not necessary has to be present, because the transcript could register everything that it is discussed. Further more, there are different tools that can help arrange those notes in an easy format and prepare to be send, for instance, Copilot from Microsoft (n.d.) or AI Companion from zoom (Zoom, 2026), Gemini in google meet (Google,n.d), or a lot of more other tools, as it can be seen in the Table 1 bellow.

Considering the PMBOK Guide the eighth edition, there are defined multiple focus area: initiating, planning, executing, monitoring and controlling, closing and focus areas as a whole. The use of AI powered tools, could be used by professionals based on their value that it brings, company politics and it can be tailored based on the specific and unique needs of the project.

In following table are detailed AI tools example for different project management activities. For initiating the project, the proposed tools are based on Generative AI capabilities, splitted into project management focus areas.

The below list of tools exists on market and most of them have free trial versions, but also paid version with different functionalities, based on either number of users that are using it or functionalities that

can be used. The list detailed in Table 1, does not represent an exhaustive list and it is intended for illustrative purposes, and does not cover all possible capabilities and solutions.

Table 1. Results of PM activity mapped with AI tool and capability

Focus area	PM Activity	Example of AI tool/platform	Capability/ Details
Initiating	Project charter	Bit.AI, Quillbot, ChatGPT, Claude, PMI Infinity (Shrivastava et al., 2025), Click Up	Generate project charter based on specific input
	Business case	Business Case Hub's AI Toolkit (Business Cases, n.d.), GenAI tools, Venturekit	Creation of the business case, description of the proposed solution and justifications
Planning	Scope Statement	PlusAI (2025), Taskade	Using proposed templates generate a statement proposal
	Gantt chart	Click up, Gantt Chart AI, Formula Bot	Timeline proposal in a Gantt form
	Project Planning	Microsoft Planner, Monday.com, Asana, Click Up, Trello	Tools for professionals to organize work and plan the items of the project
	Requirement analysis	Copilot for devops, Chat GPT	Creating requirements based on notes or documents; generation user story in a certain format and propose acceptance criteria
	Document analysis	Claude, ChatGPT, Copilot, Gemini	Summarize large documentation; respond to questions related to the details from the document
	Resource allocation	Taskade, Float	Identification of needs and available resources
	Cost estimation	CostGPT AI, GenAI	Analysis of the past project and predict based on historical data
	Risk management	GenAI tools	Identification of potential risks and detect potential issues and possible actions
Executing	Minutes of meetings	AI Companion from Zoom, Copilot from Microsoft, Fireflies, Otter, Fellow, Fathom, Granola	Meeting transcription, AI meeting assistant, note takers
	Item works execution and tracking	Asana, Click up, Wrike	Visibility for tracking of the real time status; creation of dashboards
	Grammar correction	Grammarly, GenAI tools	Correction of text and suggestions
	Automatization	Zapier	Connection between different application
	Team collaboration	Click up, Hive	Facilitate communication, centralize items and sharing easily between members

	Documentation	Confluence, GenAI	Possibility to write in a collaborative way using different templates or receive suggestion for documentation or completion
Monitoring and control	Tracking	JIRA Atlassian, Trello	Work items visibility and progress tracking
	Dashboard visualization	Monday.com	Visualise work in real time and aggregate items based on filters
Closing	Project documentation	GenAI	Identification for lesson learned, summarize pattern and proposal for next steps for improvements
	Retrospective	Confluence, Miro	Offers templates for facilitating team retrospective and lesson learned
Focus area as a whole	AI Assistant	Motion, Notion, Copilot, PMI Infinity	Document analysis, document creation, project plan, Gantt chart, workflow, calendar, meeting notes, summary, generate reports, offer template or checklist
	AI Agent (surface agent)	Google (2026), Microsoft project	Personalized support
	AI Agent (autonomous background process)	Google (2026)	Proactively identify and address potential issue; analyse data

Source: Elaboration based on proposed framework, literature and PMBOK GUIDE

This table emphasizes practical input for professionals for each activity that can be done by a project manager and how it is beneficial.

At the same time, the AI tools can be grouped in different ways, for instance, based on Generative AI (creating document, rephrasing or Grammarly correcting documentation, create templates), predictive analysis (cost estimation, risk identifications) or AI agents (assist with decisions, optimization).

Considering the practical application for Artificial intelligence in project management focus area, there are different benefits that can be used. In planning phase, professionals can benefit from AI tools analyzing large volumes of past project data to finding patterns and trends (Pan and Zhang, 2021), break down into smaller tasks or suggest timelines. Moreover, these tools can create reports or highlight issues on specific configurations during monitoring and controlling phase or even suggest ways to improve going forward, during closing phase (Microsoft, n.d.).

Discussions

The development of AI has a positive impact on project management domain by helping professionals with distributing resources, create visual representation, generate new ideas, provide insights based on past data from older projects and supporting communication amongst team members and stakeholders.

AI tools can be used either to automate routine tasks, to assist professionals in different activities or to augment their work. There can be identified different benefits on the utilization of AI in practice, such as increase efficiency and extended capabilities (Google, 2026), fewer human errors or more informed decision (Vergara et al. 2025).

AI tools are bringing a lots of benefits in certain conditions and for different projects. However, not

all the time using AI is beneficial. For instance, if there is no historical data, or are high risks tasks (Microsoft, 2023) or the environment is unpredictable, involved ethical consideration (Google, 2026), or even costs for smaller organizations (Adamantiadou and Tsironis, 2025).

As a limitation of this analysis, because there is a very rapid evolution of AI tools, the mapping of the results could become outdated very fast, if new functionalities will be added or some of them descoped.

Conclusions

AI is capable of processing big volumes of data and to produce helpful input. As also Ruiz et al. (2026) observed in their study, AI systems based on large language models (LLMs) have strong capabilities, however the benefits depends on how are incorporated in activities and how the users are using it and have trust in using it. According to study of Adamantiadou and Tsironis (2025), there is still a resistance to adopting AI involving human interactions. There is also concerns over job displacement and interpretability of AI driven decisions.

As also highlighted in the result of this analysis and also by the study of Nenni et al. (2025) AI evolution rather support and enhance project manager roles instead of replacing it.

Moreover, AI continues to grow and companies to adopt it for its promised benefits. According to Accenture (2026) survey, 78% of C-suite leaders use AI tools daily in their work and 86% plan to increase AI investment in 2026.

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SECTION 7: ECONOMIC GEOGRAPHY

THE PERI-URBAN SPACE OF CHISINAU MUNICIPALITY: CONCEPTUAL DELIMITATIONS AND IMPLICATIONS FOR PUBLIC POLICIES

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Abstract: *The article analyzes the peri-urban space of Chisinau municipality from the perspective of its conceptual delimitations and their implications for territorial public policies. The aim of the research is to critically examine the main approaches to the peri-urban and to highlight the relevance of this concept for territorial planning, regional development, and peri-urban governance in the Republic of Moldova. The study is based on the analysis of international, Romanian, and national specialized literature, as well as on the examination of the normative and strategic framework relevant to territorial development. Methodologically, the research has a theoretical-analytical and synthetic character and is oriented toward clarifying the relationship between concepts such as peri-urban, suburban, functional urban area, urban-rural continuum, and urban influence area. The findings show that peri-urban space cannot be treated as a mere extension of the city or as a peripheral rural territory, but must be approached as a hybrid, dynamic, and functional territory. It is subject to pressures generated by urban expansion, land conversion, daily mobility, and socio-economic transformations. For the Republic of Moldova, the study highlights the need to integrate the peri-urban dimension more explicitly into regional development policies, territorial planning, and the management of localities under the influence of Chisinau municipality. Such an approach may contribute to more coherent territorial governance and to reducing fragmentation between urban, rural, and regional policies.*

Keywords: *peri-urban space; Chisinau municipality; conceptual delimitations; public policies; regional development; territorial governance.*

JEL: R11, R14, R58, O18, Q15

Introduction

In the context of intensifying urbanization processes, peri-urban space has become an important analytical category for understanding current relations between city and countryside. It can no longer be interpreted only as a physical contact zone between the urban and the rural environment. It must be analyzed as a hybrid territory in which residential, economic, agricultural, ecological, and institutional functions intersect (Perpina Castillo et al., 2023; Cattaneo et al., 2022; Ianos et al., 2024). The relevance of the topic results from the fact that peri-urban spaces concentrate many of the contradictions of contemporary territorial development. On the one hand, they support the expansion of housing, the location of new investments, and the diversification of economic activities. On the other hand, these processes may generate landscape fragmentation, the reduction of agricultural land, pressure on infrastructure, and insufficient institutional coordination (Spyra et al., 2021; Spyra et al., 2025; Caizer et al., 2026; Matei, 2024). Therefore, the conceptual delimitation of the peri-urban is not only a theoretical exercise. It is, in fact, a condition for substantiating appropriate public policies. The motivation for choosing this topic is related to the doctoral research on the socio-economic reconfiguration of the peri-urban area of Chisinau municipality in the context of sustainable regional development. In the Republic of Moldova, this issue is particularly relevant. The relations between Chisinau municipality and the adjacent localities are dynamic, but the conceptual and institutional framework used to explain them remains insufficiently defined. Existing studies highlight the strong

polarization exerted by the capital and the territorial disparities between Chisinau and the other development regions (Matei and Hachi, 2020; Mariciuc and Bulat, 2020). Research on the Chisinau agglomeration also demonstrates significant spatial and functional transformations in nearby localities, determined by demographic pressure, weakly controlled urban development, and the intensification of land relations (Sirbu and Cujba, 2020).

The aim of the study is to critically examine the main conceptual delimitations of peri-urban space and to highlight their implications for territorial public policies. To achieve this aim, the article pursues three objectives: 1. to critically analyze the main conceptual approaches to peri-urban space; 2. to clarify the relationship between the peri-urban, the suburban, the functional urban area, and the urban-rural continuum; 3. to evaluate the implications of these delimitations for the development of public policies, territorial planning, and peri-urban governance.

From a methodological point of view, the research has a theoretical-analytical and synthetic character and is based on the critical analysis of specialized literature and on the comparative use of studies relevant to the European, Romanian, and Moldovan contexts. The article analyzes works on peri-urban dynamics, land-use conversion, the protection of open spaces, urban-rural relations, and planning dysfunctions in territories under the pressure of urban expansion (Spyra et al., 2021; Ianos et al., 2024; Caizer et al., 2026). For the case of the Republic of Moldova, the focus is placed on studies concerning the Chisinau agglomeration, the expansion of built-up areas, changes in land structure, and the relations between the urban core and peri-urban localities (Sirbu and Cujba, 2020; Matei and Hachi, 2020).

In the Republic of Moldova, the peri-urban dimension must be integrated more explicitly into territorial planning and regional development policy. These documents often operate with notions such as influence area, growth pole, or functional urban area, but they insufficiently valorize the peri-urban category (Mariciuc and Bulat, 2020; Law of the Republic of Moldova No. 438/2006). In previous periods, peri-urban management was not developed as a distinct direction of public intervention, although the transformations around Chisinau municipality show the need for an integrated, anticipatory, and coordinated approach.

Conceptual delimitations of peri-urban space

Peri-urban space is one of the most problematic and relevant analytical categories in contemporary urban and regional geography. The difficulty of defining it derives from its intermediate position between the urban and the rural. Peri-urban space does not fully identify with either of these categories. In the specialized literature, the peri-urban is interpreted as a territory of functional and socio-economic interference. It results from the expansion of the city into surrounding spaces and from the reconfiguration of urban-rural relations under the influence of mobility, the land market, and contemporary economic transformations (Perpina Castillo et al., 2023; Cattaneo et al., 2022; Ianos et al., 2024).

The first essential dimension of conceptual delimitation concerns the relationship between the peri-urban and the traditional urban-rural dichotomy. Recent studies consider this dichotomy insufficient for capturing current territorial realities, because an urban-rural continuum develops between the city and the rural proper. This continuum is characterized by different degrees of density, accessibility, connectivity, mobility, and access to services. From this perspective, the peri-urban no longer appears as a marginal or residual zone. It becomes a strategic interface where flows of population, goods, services, information, and investment are concentrated, with direct effects on regional development (Perpina Castillo et al., 2023; Cattaneo et al., 2022).

Romanian and Central European literature provides several similar, but not identical, definitions. Pecingina (2012) describes the peri-urban area as an area located around urban agglomerations, subject to the advance of urban expansion, a place of contact and confrontation between the urban world and the rural world, with profound demographic, economic, social, and cultural consequences. In the same direction, Benedek (2019) emphasizes that peri-urban areas must be understood as

functional territorial units that provide mutual and complementary advantages to the actors involved, but only under the conditions of effective territorial governance structures. Thus, the peri-urban is not only a spatial reality, but also an institutional and relational one.

At the conceptual level, the distinction between peri-urban, suburban, and functional urban area is useful. These concepts partly overlap, but they are not equivalent. The suburban is associated mainly with residential expansion and low-density morphology at the edge of the city. The functional urban area emphasizes mobility relations, commuting, and economic integration. The peri-urban is distinguished by its processual and hybrid character and designates a territory undergoing transformation, in which urban functions disseminate into formerly rural spaces (Cattaneo et al., 2022; Perpina Castillo et al., 2023; Ianos et al., 2024).

This terminological diversity has important methodological and practical consequences. Sareen and Haque (2023), in a bibliometric synthesis of research on peri-urban planning, show that the field has expanded beyond classical definitions and currently includes topics such as ecosystem services, green infrastructure, spatial equity, land-use change, investment pressures, and multiscalar governance. In other words, peri-urban space can no longer be reduced to the status of a simple urban "fringe". It must be analyzed as a complex and multifunctional territory in which residential, agricultural, ecological, economic, and political-administrative interests intersect and compete.

For the Republic of Moldova, the problem of conceptual delimitation is even more relevant because strategic and public policy documents more frequently operate with notions such as "influence area", "growth pole", or "functional urban area", without clearly enough integrating peri-urban space as a distinct object of analysis and intervention. The study on urban development centers in the Republic of Moldova emphasizes the polarization relations exercised by cities, accessibility, services, and the territorial influence of urban centers. However, it does not systematically develop an explicit conceptualization of the peri-urban, although this space is implicitly involved in all these relations (Mariciuc and Bulat, 2020). At the same time, Matei and Hachi (2020) highlight the determining role of urban and peri-urban space in the territorial organization of the Centre Development Region, underlining its strong dependence on Chisinau and on the polarizing dynamics of the capital.

Therefore, the conceptual delimitation of peri-urban space must be understood as an indispensable exercise not only for theoretical rigor, but also for substantiating public intervention. Without clarifying its hybrid and relational nature, the peri-urban risks remaining trapped between urban and rural policies, without adequate instruments for planning, coordination, and regulation.

Transformations of peri-urban space in the context of contemporary urbanization

The dynamics of peri-urban space are closely linked to contemporary processes of urbanization, metropolization, and economic restructuring. The specialized literature shows that peri-urbanization is a continuous process of transforming territories located at the edges of cities. It is determined by the expansion of built-up and artificialized surfaces over agricultural, natural, semi-natural, or undeveloped land. This expansion is driven by multiple factors: demand for housing near the city, the desire to access cheaper land, transport infrastructure, investment dynamics, increased mobility, and changing lifestyles (Spyra et al., 2025).

One of the most important consequences of these processes is land-use conversion. Spyra et al. (2021) show that peri-urbanization manifests directly through the transformation of agricultural land, forests, and other open spaces into artificial surfaces, with effects on biodiversity, ecological connectivity, and the provision of ecosystem services. In all regions analyzed by the authors, peri-urban spaces are under constant pressure. Their protection requires not only conservation measures, but also a reconsideration of the relationship between built-up growth and the maintenance of ecological balance.

At the same time, peri-urbanization does not mean only physical expansion. It also implies functional restructuring. In these territories, commuting intensifies, economic activities diversify, and new forms of entrepreneurship emerge. The social composition of the population also changes. Matei (2024),

analyzing the peri-urban area of Suceava municipality, shows that proximity to urban centers reduces dependence on agriculture. Peri-urban communities gradually orient themselves toward production, services, and activities connected to the urban market. Similarly, research on the Cluj metropolitan area highlights rapid demographic growth in peri-urban communes and massive residential development. These transformations are accompanied by a fragmented legislative and institutional framework that is insufficiently adapted to managing change (Galos, 2025).

In post-socialist spaces, these processes acquire additional particularities. Caizer et al. (2026) demonstrate that urban expansion in Central and Eastern Europe cannot be understood outside the post-socialist context, which radically changed land ownership, planning mechanisms, and institutional relations. The liberalization of the land market, administrative decentralization, and the lack of effective regional or metropolitan policies favored fragmented developments that are often difficult to manage. In Romania, after 1990, peri-urbanization was stimulated by a change in the housing ideal, from collective housing to individual housing with its own green space, as well as by greater autonomy of local authorities in attracting investments and authorizing construction. In the absence of higher-level territorial coordination, this autonomy generated competition between administrative-territorial units and accentuated development incoherence.

The same logic is confirmed by Galos (2025), who links the development of peri-urbanization in Romania to the withdrawal of the state from housing policies, accelerated privatization, and the emergence of land and real estate markets after 1990. The author shows that the liberalization of land ownership and the facilitation of the conversion of agricultural land into buildable land created favorable conditions for uncontrolled urban expansion and the development of satellite residential complexes near economically dynamic cities. In many cases, this process was presented as a housing solution "closer to nature". In practice, however, it generated the profound transformation of rural spaces, the destruction of natural elements, and increased dependence on car mobility.

In this respect, the peri-urban is marked by a structural contradiction. Although it responds to real needs for housing, accessibility, and economic expansion, it frequently produces major dysfunctions. Caizer et al. (2026) emphasize that excessive residential development in the peri-urban often leaves too little space for community services, green infrastructure, and ecologically balanced areas. The lack of coherence between the urban and the peri-urban generates functional blockages that directly affect quality of life. In addition, these processes are amplified by the fact that the pace of real estate development exceeds the capacity of local authorities to regulate, equip, and coordinate the territory adequately.

For the Republic of Moldova, the case of Chisinau is particularly relevant. The research conducted by Sirbu and Cujba (2020) on Stauceni commune demonstrates that the peri-urban area of Chisinau is undergoing a period of significant transformation, characterized by weakly controlled urban development, the intensification of land relations, and changes in land use. The authors underline that, in the absence of a rapid adaptation of spatial planning to the pace of demographic and investment changes, there is a risk of compromising infrastructure projects and wasting land in suburban spaces. At the same time, Matei and Hachi (2020) show that the Centre Development Region has the lowest degree of urbanization among the development regions of the Republic of Moldova, which strengthens the centrality of Chisinau and its pressure on peri-urban territories.

Therefore, the transformations of peri-urban space must be interpreted as complex processes of territorial reorganization. They are not only effects of urban growth. They combine changes in land use, mobility, economic restructuring, lifestyle changes, and institutional tensions. In the absence of adequate governance, these transformations may lead to fragmentation, territorial competition, and imbalance.

Implications for public policies and territorial governance

The complexity of peri-urban space generates direct implications for public policies and territorial governance. First, conceptual ambiguity produces institutional ambiguity. If the peri-urban is not

defined as a distinct territory, it remains between urban and rural policies. In practice, this space is treated either as a secondary extension of the city or as a rural territory undergoing transformation. In both situations, dedicated instruments for coordination, regulation, and intervention are missing (Cattaneo et al., 2022; Spyra et al., 2025).

This problem is also visible in the Republic of Moldova. The normative framework includes important instruments for regional development, territorial planning, and urbanism. However, the peri-urban category is not sufficiently valorized as an explicit object of public policies. Law No. 438/2006 on regional development in the Republic of Moldova defines functional development regions, interregional cooperation, the institutional framework, and the instruments of regional development policy (Law No. 438/2006). These provisions provide a basis for coordinating territorial development, but they do not formulate a distinct approach for peri-urban and suburban areas. Therefore, the integration of the peri-urban into public policies must start from the existing regional framework, while also completing it with functional planning instruments around major urban centers.

An additional reference point is the Urbanism and Construction Code No. 434/2023. It establishes a unified normative framework for territorial planning, urbanism, the authorization and execution of design and construction works (Urbanism and Construction Code No. 434/2023). From the perspective of the peri-urban, this framework is important because it regulates urban planning documentation and discipline in territorial planning. However, the mere existence of urban planning rules is not sufficient. They must be connected with regional development policy, mobility plans, the protection of agricultural land, and the management of public services in localities under the influence of the city.

The National Plan "Building European Moldova" - 20 Government Actions confirms the current orientation toward the modernization of localities, infrastructure, energy efficiency, water and sanitation, roads, and public services (Government of the Republic of Moldova, 2023). These directions are also relevant for peri-urban spaces. Around Chisinau, infrastructure modernization cannot be separated from residential pressures, commuting, construction expansion, and the need for coordinated public services. Therefore, the peri-urban may become an operational category that links the modernization of localities with territorial planning and regional development.

Land-use planning remains one of the most important directions of intervention. European studies show that effective policies must maintain the balance between built-up and non-built-up areas. They must protect fertile agricultural land and integrate green infrastructure into territorial strategies. Spyra et al. (2021) show that coherent legal and planning instruments are needed at the regional level, including green-blue corridors, land readjustment mechanisms, and climate change adaptation measures. In the absence of these instruments, the peri-urban becomes a space of confrontation between housing, agriculture, business, recreation, nature protection, and the public interest.

Public policies for the peri-urban also require interinstitutional coordination. Spyra et al. (2025) show that effective peri-urban governance cannot rely on a single instrument. It requires combinations of legal, economic, financial, participatory, and methodological instruments. These "governance mixes" can mobilize public and private resources. They can include multiple actors and respond simultaneously to challenges related to climate change, the circular economy, public participation, and sustainability. For the Republic of Moldova, this approach is relevant because the peri-urban space of Chisinau exceeds the administrative limits of the municipality and involves several localities, competences, and interests.

An important shortcoming of current policies is their dependence on predominantly top-down approaches. A top-down approach is understood as a model in which decisions are formulated at higher administrative levels and subsequently applied at the local level. Spyra et al. (2025) observe that many peri-urban policies depend excessively on vertical regulations and public funds. Citizen and local actor participation often remains limited. However, the contested character of the peri-urban

requires the involvement of communities, landowners, investors, local authorities, and regional structures. Without such participation, policies risk remaining formal or being blocked at the implementation stage.

The experience of post-socialist spaces shows that lack of coordination may accentuate territorial dysfunctions. Caizer et al. (2026) link uncontrolled peri-urban development in Romania to competition between local administrations, the lack of updated metropolitan strategies, and insufficient cooperation between authorities. This finding is also useful for the Republic of Moldova. Around Chisinau, the lack of a clear approach to the suburban and the peri-urban may maintain development within a logic of dispersion and land pressure. Integrating this category into public policies would allow a transition from fragmented management of urban expansion to coordinated territorial management.

Consequently, the major implication for public policies is the recognition of the peri-urban as a distinct territory of planning and governance. This requires several concrete directions: clarifying conceptual and methodological delimitations; including the peri-urban in urban and regional development strategies; metropolitan and intercommunal coordination; correlating residential development with infrastructure, services, and mobility; protecting agricultural land and open spaces; and using mixed instruments of regulation, stimulation, and participation. Only in this way can the peri-urban be managed as a key space of sustainable regional development, not as a secondary effect of urban expansion.

Conclusions

The analysis confirms that peri-urban space represents an essential territorial and conceptual category for understanding contemporary transformations produced at the urban-rural interface. Its complexity derives from the hybrid, dynamic, and relational character of this type of territory, in which processes of urban expansion, mobility, functional change, and land-use conversion occur simultaneously and interdependently (Perpina Castillo et al., 2023; Cattaneo et al., 2022; Ianos et al., 2024). In this regard, the study has shown that the peri-urban cannot be treated either as a simple extension of the city or as a peripheral rural territory. It must be approached as a distinct territorial category of organization and intervention, influenced simultaneously by urban, rural, economic, institutional, and ecological logics.

A first important result of the research is that the conceptual delimitation of peri-urban space remains a fundamental condition for the rigor of scientific analysis and for the coherence of public intervention. The diversity of definitions and criteria used in the specialized literature—morphological, functional, administrative, economic, or mobility-related—reflects not only the interpretative complexity of the concept, but also the difficulty of operationalizing it in a unified manner (Benedek, 2019; Pecingina, 2012; Sareen and Haque, 2023). At the same time, this very plurality demonstrates that the peri-urban must be understood in a relational and processual key, not in a strictly descriptive one.

A second result concerns the nature of the transformations that define this type of territory. The research has shown that peri-urbanization involves the expansion of built-up areas, the reorganization of economic and residential functions, the intensification of commuting, and increased pressure on agricultural land and open spaces. It also produces significant imbalances between the pace of territorial growth and the capacity for regulation and infrastructure provision (Spyra et al., 2021; Spyra et al., 2025; Caizer et al., 2026). In post-socialist spaces, these processes are accentuated by land market liberalization, administrative fragmentation, and the weakening of planning control, which favor discontinuous, dispersed, and difficult-to-manage forms of development (Ianos et al., 2024; Galos, 2025).

Regarding the Republic of Moldova, the analysis allows the conclusion that the study of peri-urban space is particularly relevant in the context of the polarization exerted by Chisinau municipality and

the territorial disparities existing between the capital and the development regions. The case of Stauceni commune and the observations on the dynamics of the Centre Development Region demonstrate that peri-urban territories around Chisinau face accelerated processes of functional and spatial transformation, marked by demographic pressures, land conversions, and insufficiently controlled urban development (Sirbu and Cujba, 2020; Matei and Hachi, 2020). This situation confirms the need for a clearer and more systematic approach to the peri-urban in national research and in public policy documents.

At the applied level, the major conclusion is that peri-urban space must be recognized as a distinct object of territorial planning and governance. Approaching it exclusively through urban or rural policies is insufficient because its problems exceed administrative boundaries and require intercommunal, metropolitan, and regional coordination. In this respect, the consulted literature supports the need for integrated instruments capable of correlating residential development, infrastructure, mobility, the protection of agricultural land, and the conservation of open spaces (Spyra et al., 2021; Spyra et al., 2025; Mariciuc and Bulat, 2020). For the Republic of Moldova, this means that urban and regional development policies should integrate the peri-urban dimension more explicitly, especially around the main polarizing centers (Chisinau and Balti).

In conclusion, the study demonstrates that peri-urban space is not a simple urban periphery, but a strategic territory of contemporary development. This space concentrates opportunities for growth and functional integration, as well as risks of imbalance and fragmentation. Clarifying the conceptual delimitations of the peri-urban and analyzing its implications for public policies represent a necessary theoretical undertaking. At the same time, these delimitations are a condition for formulating territorial interventions that are more coherent, more integrated, and more oriented toward sustainability. In the case of the Republic of Moldova, such a perspective may contribute to understanding the reconfiguration of the space around Chisinau and may support the substantiation of public policies capable of managing the relations between the urban, peri-urban, and rural more effectively.

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SOCIO-ECONOMIC AND EVOLUTIVE ASSESSMENT OF SMALL AND MEDIUM VILLAGES IN THE NORTHERN REGION OF THE REPUBLIC OF MOLDOVA IN THE CONTEXT OF THE RESULTS OF THE 2024 POPULATION AND HOUSING CENSUS

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Abstract: *The purpose of this paper is to assess the socio-economic and evolutionary status of small and medium-sized villages (SMV) in the Northern Development Region (NDR) of the Republic of Moldova. The objectives of the study are: a) systematization and general characterization of small and medium-sized villages in the study region; b) assessment of the dynamics of small and medium-sized villages between 1959-2024; c) identification of current problems and opportunities for the development of small and medium-sized villages in the NDR. The paper is based on consulting specialized literature, as well as processing statistical data on the dynamics of the population of human settlements in the NDR, based on population censuses conducted on the territory of the Republic of Moldova between 1959-2024.*

Key words: *population, small and medium-sized villages (SMV), census, North Development Region (NDR).*

JEL: J11, R23, R58

Introduction

The NDR is one of the five functional regions of the Republic of Moldova. It borders the Central Region (Ungheni, Telenești and Soldanești districts) to the south and Transnistria to the southeast (Camenca district). From an administrative-territorial point of view, the NDR includes three municipalities (Bălți, Edineț, Soroca) and 11 districts (Briceni, Edineț, Dondușeni, Drochia, Fălești, Florești, Glodeni, Ocnița, Râșcani, Sângerei, Soroca) (Figure 1) with a population of 627,911 inhabitants (2025), ranking, from this point of view, third among the five functional development regions of the country. The largest urban center of the region is the municipality of Bălți, the second city in the Republic of Moldova by the number of inhabitants. The North Development Region has an area of 10014 km² (equivalent to approximately 1,001,394 thousand ha), representing 29.6% of the total area of the country (14).

The NDR in general and its population in particular have been quite intensively researched in recent years (Hachi, M., Constantin, M., Lozovanu, D. 2021; Bulimaga, C., Bacal, P., Țugulea, A., Certan, C., 2023). The rural population of the Republic of Moldova has also been described in some studies (Mătcu, M., Hachi, M., 2008), but neither before nor after the population and housing census conducted in 2024 has any work been published with any analysis of the population of small and medium-sized villages (SMV) in the region.

The increasingly difficult geo-demographic and socio-economic situation of small and medium-sized villages in the Republic of Moldova, especially those located on the outskirts of administrative districts, represents a major problem for the central and local public administration (CPA and LPA), which requires major, but absolutely necessary, financial resources. The importance of a comprehensive study of this category of problematic localities also results from the frequent practice of allocating financial resources and approving the financing of regional and local projects in the established priority directions, without taking into account the geo-demographic situation and its

evolution in the near future, especially the increasingly intense migration of young people and the more accelerated demographic aging of small and medium-sized villages. These unfavorable demographic processes significantly reduce the capacity of the LPA to manage current community problems, such as the supply of quality drinking water, the proper disposal of waste and wastewater, resilience to climate change and risks, etc. In this context, analyses and forecasts of the demographic situation in particular and the socio-economic situation in general of the SMV are necessary, as well as proposals for economic activities that would remedy the created situation.

Regarding the classification of villages, in the context of the decrease in the rural population, we considered the following typology more appropriate: medium-sized villages - rural localities with a population between 501 and 1500 inhabitants; small villages - 201-500 inhabitants; very small villages - with less than 201 inhabitants.



Figure 1. NDR on the map of the Republic of Moldova

Source: <https://adrnord.md/taboneview.php?l=ro&idc=542&id=4613&t=/Regiunea-de-Dezvoltare-Nord/Regiunea-de-Dezvoltare-Nord/Harta/>

Basic content

The NDR was the promoter of the demographic transition in the Republic of Moldova. Starting with the decrease in the birth rate since the 1950s, the demographic transition was evident between 1959-1989 with the reduction of the population only in the rural localities of the northern region. In the following period, the negative dynamics is recorded in most localities of the state, including those in the DNR (8, pp.10-20).

Evolution of the number of small and medium-sized villages.

During the period 1959-2024, the number of small and medium-sized villages in the NDR recorded an oscillating evolution, against the background of a general positive trend. (Figure 2). Only in the years 1959-1970 is a general negative dynamic observed, caused by the increase in the population and the transition of some medium-sized villages to the category of large villages, as a result of the high natural increase. Thus, at the beginning of the reference period in the DNR there were 364 small and medium-sized villages, or 66% of the total rural localities of the region. The highest growth rate of the number of small and medium-sized villages in the DNR was recorded in the intercensal period 2014-2024 (from 423 to 489) – by 15%. This is taking place against the backdrop of the drastic decrease in the rural population in the republic and implicitly in the region in the last intercensal period, which caused many rural localities to move from the category of large villages to that of small and medium-sized ones.

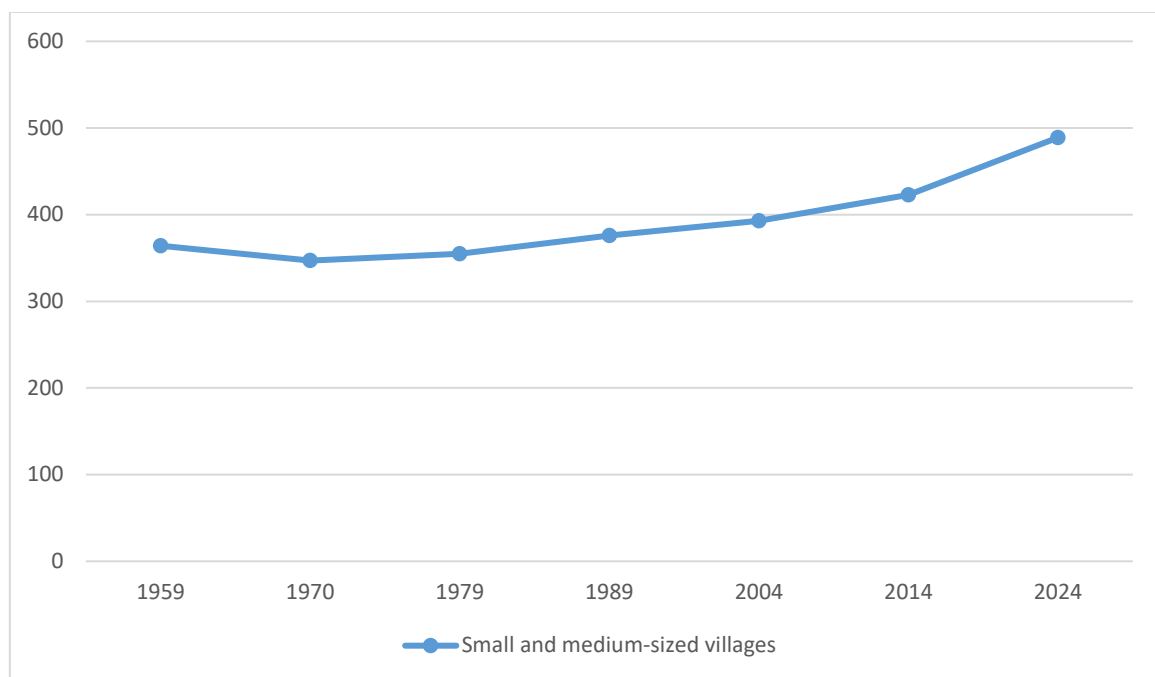


Figure 2. Evolution of the number of small and medium-sized villages in the NDR during the period 1959-2024

Source: The Population and Housing Census (1-3, 22-24).

According to the 2024 Population and Housing Census (RPL) data, out of 552 rural localities surveyed in the RDN, 488 or 88% are small and medium-sized villages, including 430 (78%) medium-sized villages, 31 (5.6%) small villages and 22 (4%) very small villages, and five villages were left without inhabitants (Figure 3).

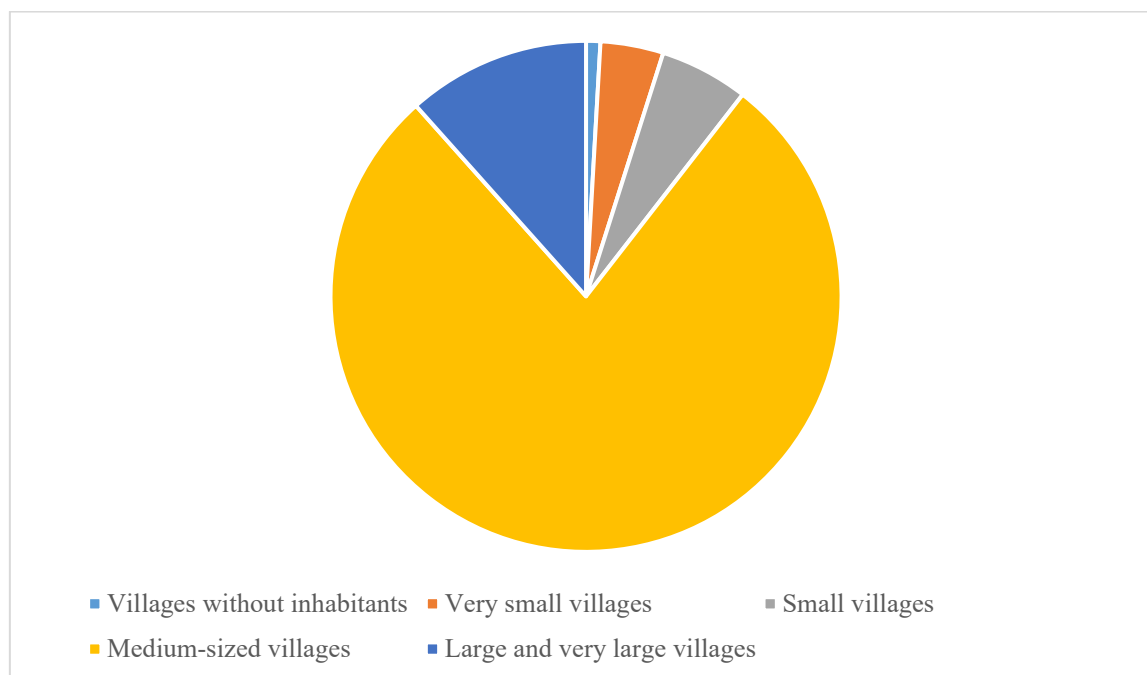


Figure 3. Types of villages in the NDR by population

Source: The 2024 Population and Housing Census (https://statistica.gov.md/ro/statistic_indicator_details/60)

Among the territorial-administrative units of the NDR, the most SMV are in Falesti district - 67, the highest percentage of SMV is in Falesti district - 94.3, and the lowest share of this type of villages is attested in Drochia district - 73.7%, so in all districts the share of SMMs among rural localities is overwhelming (Figure 4).

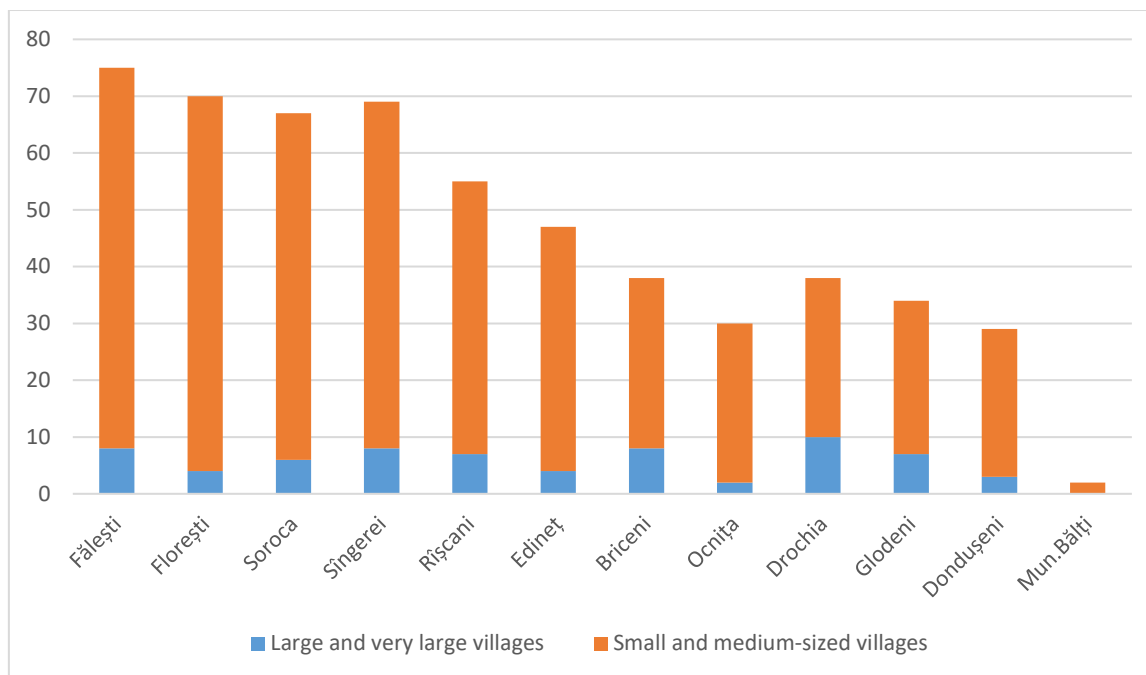


Figure 4. Share of SMV in the territorial-administrative units of the NDR

Source: The 2024 Population and Housing Census (https://statistica.gov.md/ro/statistic_indicator_details/60)

Evolution of the population of small and medium-sized villages

The dynamics of the population is a complex demographic process, which manifests itself under the synergistic influence of natural factors (climate, water resources, fertile soils, plant or animal food resources), socio-economic, ethnic-confessional, political or ecological, etc. The evolution of the rural population was determined by the synergistic action of natural and socio-economic factors, but also by the policies promoted in the analyzed period, marked by significant changes in reproductive and migratory behavior. The rural population of the NDR, after an increase that began in the 1950s of the last century, begins to decrease, unlike the total population of the region, already in the sub-period 1970-1979, a fact due to the intensification of urbanization in the 1970-1980s (Table 1).

Table 1. Evolution of the population of the NDR by categories, thousands of inhabitants

Population categories	Population Census Years						
	1959	1970	1979	1989	2004	2014	2024
Total population	882	1008	1055	1094	969	827	609
Total rural population	735	767	748	703	664	581	385
Population of small and medium-sized villages	250	238	239	245	253	262	247

Source: The Population and Housing Census (1-3, 22-24).

The maximum population growth of small and medium-sized villages in the NDR is attested in the intercensal sub-period 1959-1970, as a result of the high birth rate, but also of slower urbanization. The maximum increase in population during the period 1959-1970 is observed in the following small and medium-sized villages: Pavlovca (by 106%, from 60 to 124 inhabitants) in the Briceni district, Inundeni (by 76%, from 180 to 316 inhabitants) and Țepilova (by 59%, from 596 to 949 inhabitants) in the Soroca district, Valea Norocului (by 59%, from 308 to 490 inhabitants), Grinăuți (by 45%) in the Ocnița district, Gordinești Noi, a suburb of the city of Edineț (plus 41%, in the period 1959-1989 the latter experienced a population increase of 177%) and Chetroșica Veche under the jurisdiction of the city hall of Cupcini (+40%).

After 1970, growth rates decreased significantly, both due to the decrease in natural increase and the intensification of urbanization processes. During this period, many rural localities in the region declined (Table 2).

Table 2. SMV in the NDR with the largest decrease in the period 1959-1989 (%)

Locality	District	Number of inhabitants in 1959	Number of inhabitants in 1989	Difference between the number of population 1989 / 1959	Ratio between the number of population 1989 / 1959
Armanca	Rîșcani	30	0	30	0%
Cuconestii Vechi	Edinet	1157	6	1151	1%
Chetrișul Nou	Donduseni	90	2	88	2%
Vantina Mica	Soroca	839	16	823	2%
Vrănești	Donduseni	502	27	475	6%
Elenovca	Donduseni	216	22	196	10%
Gavrilovca	Singerei	164	20	144	12%
Serghieni	Glodeni	150	22	128	15%
Teleseuca Noua	Donduseni	577	96	481	17%
Iachimeni	Edinet	189	36	153	19%
Ivanovca	Falesti	134	32	102	24%
Chirilovca	Briceni	62	18	44	29%

Cot	Glodeni	155	58	97	37%
Caraiman	Donduseni	241	93	148	39%
Bocicauti	Briceni	116	46	70	40%

Source: The Population and Housing Census 1959, 1970, 1979, 1989 (22-24).

The disappearance of many very small settlements during the Soviet period is due to the state policy of the time of centralized support of large settlements, and the small ones were the last to be electrified. The decline of the village of Cuconestii Vechi began with the construction of the Costești–Stânca hydroelectric power plant, when a large part of the village was covered by the waters of the reservoir during the years 1975-78, and the locals were relocated to Cuconestii Noi.

In 1989, against the background of the frontal decrease in the population number throughout the Republic of Moldova, both in rural and urban areas, due to the start of post-Soviet emigration and the sharp decrease in the birth rate.

Thus, in the period 1989-2004, the population practically disappeared in the village of Dărcăuții Noi (Soroca district), when out of 22 inhabitants at the beginning of the period, only one remained, and in the 2014 census no more inhabitants were recorded.

In the intercensal period 2014-2024, the largest decrease in the population was recorded in the villages of Florești district. The village of Caraiman in Donduseni district was left without inhabitants during this period (Table 3).

Table 3. SMV in the NDR with the greatest decrease in the period 2014-2024

Locality	District	Population in 2014	Population in 2024	Difference in the number of inhabitants	Percentage of population decrease
Caraiman	Donduseni	14	0	14	100
Nicolaevca	Florești	221	15	206	93
Evghenievca	Sîngerei	224	29	195	87
Antonovca	Florești	53	11	42	79
Alexăndrești	Rîșcani	188	41	147	78
Antonovca	Sîngerei	108	27	81	75
Frumușica	Florești	1556	731	825	53

Source: The Population and Housing Census (23-24).

At the same time, in the NDR there are also rural localities that have registered an increase in the population during the reference period. Thus, in the commune of Copăcenii in the district of Sîngerei, where, alongside the villages of Evghenievca and Antonovca where a massive population decrease was recorded (Table 3), there is the village of Petrovca, where the population increased by 11% during the period 2014-2024, increasing from 321 to 356 inhabitants. This village has a central position among the rural localities in the commune. The specifics of the population of this rural locality, in addition to the fact that its number increased during the reference period, are the majority Ukrainian ethnicity and a very organized Baptist community. Another locality in the DNR where the population increased (by 66%) during this period is the village of Țapoc, Natalievca commune, Fălești district – from 127 to 211. Here too, the majority of the inhabitants are of Ukrainian ethnicity.

The largest increase in the population during this intercensal period is attested in the village of Cucuieții Vechi, Alexăndrești commune, Rîșcani district. Here the population increased from 147 to 239, i.e. by 79%. This locality is home to the only school (gymnasium) and church in Alexăndrești commune. At the same time, also in this commune, the residence village experienced a decrease in the population of 78% (Table 3).

Thus, against the backdrop of the total decrease in the population in the DNR from 1989-2024, the number of people living in the SMV does not undergo essential changes but even experiences a slight increase (Figure 5) due to the fact that many villages in the area have moved into the SMV category.

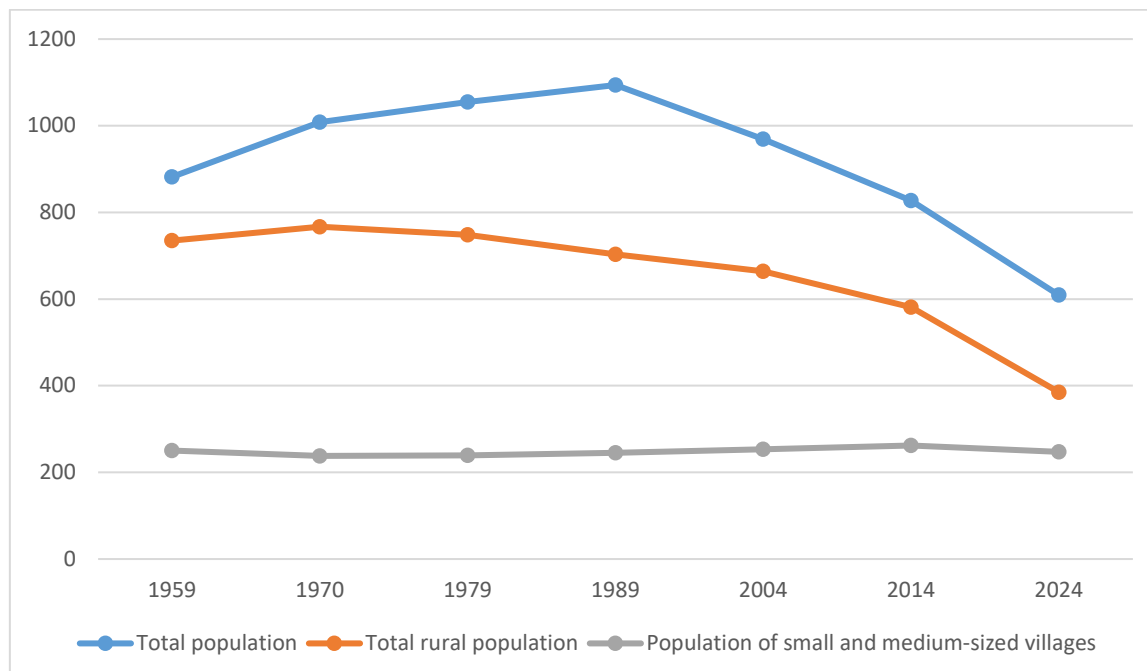


Figure 5. Evolution of the population in the NDR during the period 1959-2024

Source: The Population and Housing Census (1-3, 22-24).

Evaluative assessment of small and medium-sized villages

In the context of the mechanization of contemporary agriculture and various opportunities for emigration to more economically developed states than the Republic of Moldova, an insufficiently developed branch of the economy in the SMV of the NDR is the sphere of services in general and the HoReCa⁶ sector in particular. Due to the decreasing population density in the NDR, HoReCa enterprises in the area have to address services mainly to tourists from outside the region and the country. But in this part of the country in the SMV there is only one hotel and two restaurants (in Pocrovca, Dondușeni district and Albinețul Vechi in Făleşti district). Things are better with regard to the guesthouses in the SMV. In this HoReCa chapter, there are guesthouses in the villages of Chișcăreni (Sângerei), Cobani (Glodeni), Naslavcea (Ocnîța), Egoreni (Soroca), Hlinaia Mică (Edineț), Lunga (Florești), Vărativ, Duruitoarea Veche and Duruitoarea Nouă (Râșcani), Bocșa, (Făleşti), Japca (Florești) and Maramonovca (Drochia). However, all the guesthouses mentioned above do not offer food services (15-17). Emphasizing the need to develop the HoReCa sector in the SMV of the DNR, a SWOT analysis of their socio-economic development is proposed (Table 5).

⁶ HoReCa (or HORECA) is an abbreviation for Hotel, Restaurant, and Café/Catering, representing the food service and hospitality industry sector. It encompasses businesses that prepare, serve, or provide food, beverages, and accommodation.

Table 5. *SWOT analysis of small and medium-sized villages in the Northern Development Region*

Strengths • Pro-natalist state policies • State programs to attract young people and stimulate return migration; • SMSV presents quiet areas with high environmental comfort, being located in a picturesque natural setting; • Connection to road networks, electricity and electronic communications • Local occupations, crafts and customs, with a high tourist potential; • The presence of active LAGs; • Proximity to state border crossing points, which stimulates cross-border cooperation.	Weaknesses • Excessive fragmentation of the SDR; • Unfavorable geo-demographic situation with pronounced worsening trends; • Low level of socio-economic development; • Low employment opportunities for local people; • Insufficient local and regional financial resources; • Poor condition of roads and difficult access to many villages in the region; • Medical, educational, social infrastructure and services are insufficient.
Opportunities • Cross-border cooperation within euroregions; • Implementation of large regional projects to expand and modernize the physical infrastructure; • Promotion of traditional occupations, crafts and products for the purpose of tourism valorization; • Consistent programs for the valorization of renewable energy sources; • Tourist and educational valorization of the cultural heritage of localities with ethnic minority; • Regionalization and decentralization of public services; • Active involvement of Native Associations, LAGs.	Threats • The tense situation in connection with the military siege of the Russia on the neighboring region of Ukraine;. • The danger of further decrease in the population of small and medium-sized villages; • The reduced capacity for co-financing of local budgets; • Reducing the demand for rural labor and unattractive wages for activities performed in rural areas; • Intensification of climate changes and low resilience to their effects; • Unresolved interethnic problems; • The tense geopolitical situation in the region; • Major investment risks; • Delay in the administrative-territorial reform and its insufficiently substantiated implementation;

Source: prepared by author

In the current conditions of the development of agricultural technology and transport, the permanent proximity of a large workforce to agricultural land is no longer relevant. On the other hand, living in small communities is a natural and beneficial form of social organization for the human species. Thus, an analysis of the prospects for the continuity of small villages in the context of sustainable development is required.

Economic activities that could increase the employment rate and income of the population of small and medium-sized villages in the NDR of the Republic of Moldova include the development of rural tourism, ecotourism, gastronomic tourism, as well as the exploitation of renewable energy sources (solar and wind). Inter-community cooperation, following the example of successful Local Action Groups (LAGs), the development of cross-border projects and the attraction of the diaspora and native associations, is also very important.

Conclusions

- Between 2014-2024, the most accelerated population reduction since the Stalinist period of the Republic of Moldova is recorded, which is due, in particular, to the massive external migration of the young population, the significant decrease in natural growth and the acceleration of the process of intense demographic aging.
- However, despite the unfavorable geodemographic and geopolitical situation, there are development opportunities based on the sustainable and efficient use of local resources, but also on attracting investments and remittances, aimed at stimulating demographic growth and the socio-economic recovery of small and medium-sized villages and the NDR as a whole.

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MIGRATION AND THE RETURN OF MIGRANTS TO THE REPUBLIC OF MOLDOVA: PERCEPTIONS OF THE POPULATION AND EXPERTS FROM THE SOUTHERN REGION

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Abstract: *Mass departures from the Republic of Moldova can no longer be viewed as a passing phenomenon, they have structurally reconfigured the economy, the family, and local communities. This study starts precisely from this reality and seeks to understand how migration is experienced and interpreted by those who remain: the population of the southern region and representatives of local public authorities.*

The research combines two types of data: a survey applied among the population and local experts, conducted within a state project, and semi-structured interviews carried out within the ReMiReM project. This combination was not a formal choice, it was necessary, because numbers alone do not explain why people choose to leave or to stay.

What we found did not surprise us, but it confirmed a real tension: migration is seen, at the same time, as a solution and as a problem. Financial transfers and investments brought by migrants improve family living standards, but behind these gains lie depopulated villages, children raised without parents, and communities that grow thinner with each passing year. As for return, the desire exists, but it rarely translates into a decision. The lack of job opportunities, institutional instability, and the concrete difficulties of reintegration mean that returning home remains, for many, more of a plan than a reality.

Keywords: *return migration, Republic of Moldova, perceptions, socio-economic effects, southern region, mixed methodology.*

JEL: J11, J61, O15.

Introduction

The Republic of Moldova has been living with migration as a daily reality for more than three decades. External departures, initially sporadic after 1991, gradually transformed into a large-scale phenomenon that has profoundly influenced the demographic structure, household economies, and the life of local communities. The external migration of the working-age population, alongside declining birth rates and demographic ageing, has contributed to an accelerated population decline and the depopulation of rural areas. The specialized literature highlights the fact that the Republic of Moldova has been facing a genuine demographic crisis in recent decades, marked by mass emigration, a reduction in the stable population, and the deterioration of demographic structures (Matei, 2013; IOM, 2022).

The effects of this migratory wave are neither simple nor uniform. At the economic level, remittances have sustained domestic consumption and financed construction, education, and small businesses. At the social level, however, the price paid is considerable: fragmented families, rapidly declining rural communities, and local labour markets drained of young and skilled workers. Researchers have long documented this contradiction: migration generates real economic gains, but often pays for them with social losses that no statistic can fully capture (Castles et al., 2014). In the villages of southern Moldova, however, the tension needs no theory to be understood, you feel it in the number of children

in a classroom, in houses renovated with money sent from Italy or Germany, in elderly people left alone, and in the empty yards of otherwise well-kept households.

Faced with this reality, return migration has begun to be viewed differently, not as a failure of the migration project, but as a potential resource. The returning migrant brings not only savings, but also skills, professional experience, and a different perspective on their community of origin (Dustmann & Kirchkamp, 2002). The practical question is whether the conditions exist for this potential to translate into real development, or whether economic and institutional barriers halt it before it has any meaningful impact.

This research is anchored in the southern region of the Republic of Moldova, which includes the districts of Cahul, Cantemir, Căușeni, Cimișlia, Leova, Ștefan-Vodă, Basarabeasca, and Taraclia, located in the southern and south-eastern part of the country, on the border with Ukraine and in proximity to the Danube. The region is characterised by a predominantly agrarian economy, a lower level of infrastructure and service development compared to the central part of the country, and a high intensity of migratory processes. The specialized literature highlights the fact that this region faces persistent socio-economic vulnerabilities, generated by limited employment opportunities, the continued migration of the working-age population, and a high dependence on remittances (Hachi et al., 2026). At the same time, the depopulation process is visible in the demographic structure of rural communities, where population ageing and a deficit of young labour represent structural challenges with a direct impact on economic development and local administrative capacity (National Bureau of Statistics, 2023).

It is precisely this combination, intense migration, limited institutional resources, and vulnerable communities, that makes the southern region of the Republic of Moldova a relevant setting for understanding the dynamics of return migration. The aim of the research is to analyse the perceptions of the population and local experts regarding migration and the return of migrants, as well as the socio-economic effects of this phenomenon at the regional level. The methodology adopted is mixed, combining the analysis of secondary statistical data with surveys applied among the population and experts, and with interviews conducted in the field. The research pursues three complementary objectives: identifying the economic and social effects of migration on communities in the region; analysing perceptions regarding the opportunities and barriers to the reintegration of returned migrants; and highlighting the factors that influence the decision to return.

Theoretical framework

Return migration is neither a new phenomenon nor a simple one to explain. In the specialized literature, return migration is defined as the return of migrants to their country or community of origin after a period of residence abroad (King, 2000; Cassarino, 2004). But beyond this definition, return is a process of reintegration, economic, social, and identity-based, whose mechanisms have been approached from different theoretical perspectives, each capturing part of the reality without exhausting it entirely.

The oldest explanatory framework remains neoclassical theory, which starts from a simple logic: people migrate to where wages and opportunities are better, and return when the gap has narrowed or when they have reached their initial financial goal (Harris & Todaro, 1970; Borjas, 1989). This is a compelling explanation for the first Moldovan migration wave of the 1990s, when income differences relative to Western European countries were enormous. Its limitations, however, become visible when one tries to explain why many migrants do not return even when their earnings have long surpassed their initial goal, or why others return without having accumulated anything significant.

The New Economics of Labour Migration (NELM) shifts the focus from the individual to the household. Migration is no longer a personal decision, but a collective mechanism through which the household seeks to optimise its economic resources and manage existing socio-economic uncertainties (Stark & Bloom, 1985; Stark, 1991). Within this logic, the migrant's return is planned from the outset, it occurs when the family considers that enough has been accumulated to sustain a

life project back home. This framework explains well the dynamics of many households in southern Moldova, where the decision to leave and the decision to return are negotiated within the family, not made unilaterally.

Human capital theory adds another dimension: the migrant does not leave solely for money, but also to accumulate skills, professional experience, and new perspectives (Sjaastad, 1962; Dustmann & Kirchkamp, 2002). Upon returning home, they can leverage these resources through entrepreneurial initiatives or by accessing better-paid employment. This is the most optimistic theoretical framework regarding the potential of return migration and, at the same time, the one most dependent on the existence of an institutional environment that allows this capital to be genuinely put to use.

Migration network theory completes the picture, showing that no decision to migrate or return is made in a vacuum (Massey et al., 1993). Networks of family, friends, and former migrants transmit information, resources, and practical support, shaping individual perceptions of what it means to leave and what it means to return. In the communities with a strong migration tradition in southern Moldova, these networks are so dense that they have themselves become a decision-making factor, sometimes more powerful than pure economic calculation.

Taken together, these theories do not exclude one another, but rather complement each other. Moldovan migration was triggered by economic factors, structured through the logic of the family household, mediated by social networks, and accompanied by the accumulation of human capital which, under favourable conditions, could contribute to the development of communities of origin (IOM, 2022; Hachi et al., 2021). The question that remains open — and which the present study also attempts to answer — is whether these conditions truly exist in the southern region of the Republic of Moldova.

Research methodology

The phenomenon of return migration cannot be captured through a single type of data. Numbers tell us how many leave, how many return, and at what age, but they do not tell us why, nor what people find at home when they return. For this reason, the design of this research was mixed from the outset, combining quantitative and qualitative components not out of formal obligation, but out of the necessity to capture both the scale of the phenomenon and the lived experience of those involved (Creswell & Plano Clark, 2018).

Quantitative Component

The quantitative data were collected within the institutional project 01.08.01 "Enhancing Ecological Security and Geo-Ecosystem Resilience to Current Environmental Changes" (2024–2027), through the administration of two distinct questionnaires. The first questionnaire, addressed to the general population and entitled "Assessment of the Current State of Human Potential and Its Role in Ensuring the Resilience and Social Security of the Southern Region," targeted perceptions of migration, its economic and social effects, as well as the migration and return intentions of individuals and households in the region. It was administered to a sample of 262 respondents from 17 localities, representing eight districts: *Cahul* (the villages of Andrușul de Jos, Slobozia Mare, Văleni, and Zărnești), *Cantemir* (the village of Cania and the town of Cantemir), *Căușeni* (the villages of Cărnățeni, Sălcuța, and Zaim), *Cimișlia* (the village of Gura Galbenă), *Leova* (the village of Filipeni), *Ștefan-Vodă* (the localities of Ermoclia, Olănești, and Purcari), *Basarabeasca* (the village of Abaclia), and *Taraclia* (the village of Corten and the town of Taraclia).

From a demographic standpoint, the sample was dominated by the 41–60 age group, which accounted for nearly half of all respondents, 46.12%, reflecting the specific demographic structure of rural areas in southern Moldova, characterised by an advanced process of population ageing. Individuals aged 61 and over constituted a quarter of the sample, 25.97%, confirming the high proportion of elderly population in the localities surveyed. The 26–40 age group was represented at 22.87%, while young people aged between 18 and 25 made up the smallest segment, at just 5.04%, a finding that suggests

a low presence of young people in these communities, possibly as a direct effect of emigration among this age group.

Regarding the gender distribution, women represented the overwhelming majority of the sample, at 72.14%, compared to men, who accounted for 27.86% of all respondents. This asymmetry can be partially explained by the structure of rural households, where men are more frequently abroad, leaving women as the primary presence in the community and, consequently, the most available to participate in the study.

The second questionnaire, addressed to experts from local public administration (mayors, local councillors, public servants) and entitled "Socio-Economic Dimensioning of the Sustainable Development of Urban and Rural Ecosystems in the Southern Region," provided an institutional perspective on the issues analysed. It was administered via the Google Forms platform and recorded the participation of 273 local experts. Both questionnaires were applied during the periods May–September 2025 and March–April 2026, and the data collected were analysed using descriptive statistical methods.

Qualitative Component

The qualitative data were obtained within the project "Investigating the Dynamics of Return Migration in the Republic of Moldova: A Qualitative Analysis" / "Exploring Return Migration Dynamics: A Qualitative Analysis of Romania and the Republic of Moldova" (ReMiReM), through the conduct of 70 semi-structured interviews with returned and potential Moldovan migrants, as well as with institutional representatives. Of these, 60 interviews were carried out with migrants, repatriated individuals, and members of their families, and 10 with representatives of public authorities and field experts (ANOFM, BRD, ministries, NGOs, academia, and the private sector).

Three categories of participants were established: Category 1- Moldovan migrants who have returned to Moldova (face-to-face interviews), with migration experience in: Greece, Italy, Romania, Denmark, Germany, France, Ireland, the USA, Belgium, the Czech Republic, Portugal, Israel, and the Russian Federation. Category 2- Moldovan migrants currently abroad (online interviews), from: Romania, Italy, Belgium, the Netherlands, France, Denmark, the United Kingdom, the USA, Canada, Switzerland, and Austria. Category 3- Institutional key informants: representatives of ANOFM, BRD, NGOs, academia, and the private sector.

The interviews were conducted during the periods August–December 2024 and January–May 2025. From a demographic standpoint, the profile of the interviewed Moldovan migrants living abroad reveals a clear predominance of the 26–40 age group, which accounted for more than half of the participants, 53.33%, confirming that the young working-age population constitutes the main core of Moldovan economic migration. Young people aged between 18 and 25 represented 10% of the sample, while the 41–60 age group was present in a smaller proportion of 6.67%. A distinct segment was formed by minors aged between 11 and 17, 30%. The participation of minors in the study was conducted exclusively in their capacity as members of migrant families, with written parental consent, in accordance with the ethical principles of research. Data collected from this category were used strictly for understanding the impact of migration. In terms of gender distribution, women also predominated in this sub-segment, representing 63.33% of participants compared to 36.67% men, a trend that reflects the progressive feminisation of Moldovan migratory flows in recent decades.

In the case of returned migrants interviewed in Moldova, the demographic profile indicates a major concentration in the 26–40 age group, 57.5%, followed by the 41–60 age group, 40%, suggesting that return to the country is predominantly a phenomenon of individuals at professional and family maturity. Young people aged between 18 and 25 constituted only 2.5% of this sub-segment, which may indicate either a reluctance among young people to return, or a shorter duration of migration experience in this age group. The gender distribution revealed a majority share of women (57.5%) compared to men, 42.5%, a difference less pronounced than in the other sub-segments of the study. The qualitative data were processed using thematic analysis (Braun & Clarke, 2006), with MaxQDA

software employed to identify recurring patterns, themes, and significant narratives from the interview transcripts, complemented by an in-depth secondary analysis through the corroboration of themes with the findings of the documentary research.

The two methodological components were integrated through a data triangulation strategy, in which the quantitative results were deepened and nuanced by the qualitative perspectives obtained from the interviews (Denzin, 1978). This approach allowed for a more complete understanding of the phenomenon of return migration, capturing both the structural dimensions and the individual experiences of the participants.

Results and discussions

General Perception of Migration

The first thing the data clearly show is that there is no single perception of migration among the residents and experts of southern Moldova, and it is precisely this diversity of attitudes that says something important about how the phenomenon is experienced differently, depending on the position from which it is viewed.

Among the general population, the majority of respondents, 61.07% refuse to categorise migration simply as good or bad. They simultaneously acknowledge both its positive and negative effects, which suggests a direct and long-standing familiarity with the phenomenon: it is hard to condemn something that paid for the renovation of your house or your child's education, and hard to praise something that took half your family away. Only 16.41% consider it exclusively positive, while 22.52% view it as exclusively negative (Figure 1).

Experts from local public administration see things differently. Almost two thirds of them, 63.74% regard migration as a predominantly negative phenomenon, while only 36.26% consider it positive (Figure 1).

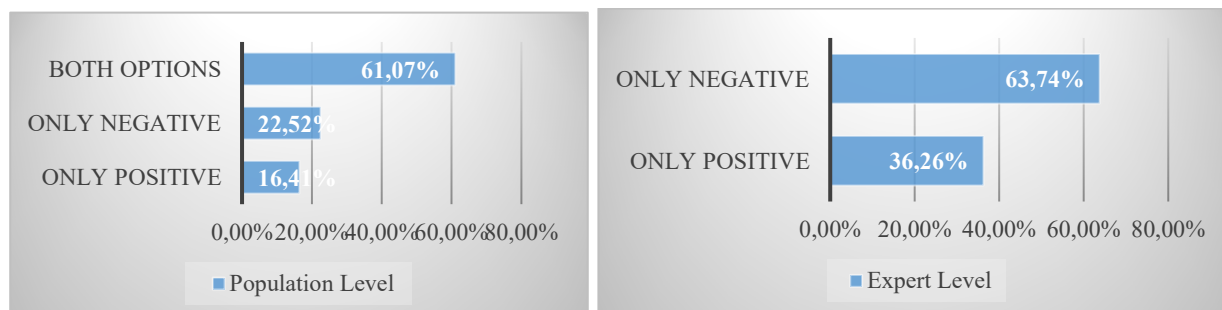


Figure 1. Respondents' Perception of the Migration Phenomenon

Source: elaborated by the author based on data from the sociological survey conducted (population level and expert level)

This difference is not surprising if we consider what a mayor sees every day: classrooms with fewer and fewer pupils, dispensaries without doctors, uncultivated fields, and a local budget that shrinks along with the population. The individual benefits of migration, remittances, human capital accumulated abroad, do not appear in his reports, but the gaps left in the community do (IOM, 2022). This divergence in perception between the population and experts is not specific to Moldova alone. The specialized literature consistently documents the tension between the individual gains and collective costs of migration, underscoring that the same phenomenon can simultaneously be a solution for the household and a problem for the community (Castles et al., 2014; Mosneaga, 2012). What our data add to this picture is that, in southern Moldova, this tension has already been internalised by the majority of the population, the 61.07% who cannot choose between positive and negative are not undecided; they are people who have learned to live with both sides of the same reality.

Economic Effects of Migration

The survey data are clear on one point: when it comes to money, migration works. The vast majority of respondents associate going abroad with increased household income through remittances, home renovation, access to goods that a local salary would not have afforded, and, not least, the accumulation of professional experience that would be difficult to obtain at home. This is not a surprise, it is, after all, the reason people leave.

What deserves attention, however, is that these economic benefits are perceived almost exclusively at the individual and family level, not at the community level. Remittances sustain the household, not the local labour market. They finance consumption and construction, rarely productive investments that would create jobs and reduce the pressure of future emigration, a dynamic well documented in the specialized literature and equally relevant to the Moldovan context (de Haas, 2010).

The in-depth interviews confirm and nuance this picture. The economic factor appears invariably as the main trigger for departure, but also as the main obstacle to return. The wage gap, infrastructure, and quality of services in destination countries create a standard of living that Moldova cannot currently match, turning the intention to return into a perpetually postponed project. One respondent articulates this tension with disarming simplicity: *"The financial part is very important... people want a better life, a more developed country, with greater opportunities."* (Cătălina, 30 years old, Romania, 10 years in migration)

This perspective is not an isolated one, it reflects the logic that Stark (1991) describes within the NELM framework: migration as a strategy for maximising family welfare, sustained for as long as the economic differential between the country of origin and the destination country remains significant. In the case of the Republic of Moldova, this differential has not narrowed sufficiently over the past thirty years to reverse the flow, and our data suggest that respondents are aware of this, even if they do not articulate it in economic terms.

Social Effects of Migration

If the economic effects of migration are perceived with ambivalence, the social ones leave no room for interpretation: respondents from both samples, the general population and the experts, describe them almost exclusively in negative terms. The depopulation of localities, the fragmentation of families, children raised without parents, and the accelerated ageing of rural communities together form a social picture that, taken as a whole, calls into question the long-term sustainability of these communities.

The quantitative data confirm this hierarchy of concerns (Table 1). Depopulation is identified as the main social effect of migration by both the general population, 43.90% and local public administration experts, 41.60%. Family fragmentation follows in second place, with 27.60% of population respondents and 20.60% of experts considering it a major effect.

Table 1. Main social effects of migration identified by respondents

Social Effects of Migration	Population/Citizens Level	Expert Level
Depopulation of localities	43,90%	41,60%
Fragmentation of families	27,60%	20,60%
Children left behind	15,40%	13,10%
Ageing of the population	10,90%	24,70%

Source: elaborated by the author based on data from the sociological survey conducted (population level and expert level)

The growing number of children left in the care of relatives is reported by 15.40% of the population and 13.10% of experts, while population ageing is felt more acutely by experts 24.70%, than by the

general population 10.90%, likely because the latter live within the community and gradually normalise it, whereas institutional representatives see it in statistics and in the absence of a workforce. The interviews add what the numbers cannot convey, the emotional dimension of these transformations. Family separation is not an abstract concept for the study participants, but a reality lived for years, sometimes from childhood: *"My father has been away for 7 years, and my mother for 5... we see each other at least once a year."* (Ana, 30 years old, Romania, 2 years in migration)
"From the age of 12 to 17 I did not see my mother... it was the most difficult period of my life." (Alexandra, 33 years old, Italy, 10 years in migration)

These testimonies illustrate a phenomenon systematically documented in research on children left behind in the context of Moldovan migration, emotional and educational vulnerabilities that accumulate silently, far from official statistics (Poalelungi et al., 2016). Separation does not only produce immediate suffering; it redefines intergenerational relationships and shapes the way in which today's children will, in turn, make the decision to leave or to stay. Sometimes, it is precisely this lived suffering that becomes the reason for return, not economic calculation, but the impossibility of accepting a life built at a distance from loved ones:

"It is far too hard. To do everything possible, to be where I wouldn't otherwise be, to be with my children, with my family. I truly cannot see a normal life at a distance." (Sorina, 30 years old, Italy, returned after 3 years in migration)

The interviews also highlight another dimension, less frequently discussed: experiences of discrimination and alienation in destination countries, which complicate the image of migration as a successful project and paradoxically fuel both the desire to return and the feeling of no longer fully belonging anywhere: *"At some point, someone will always show up to remind you that you are an outsider, that you are not from here."* (Crina, 28 years old, Romania, 9 years in migration)

This perception is not an isolated one. It reflects an identity tension that the literature associates with the advanced stages of migration, the moment when the migrant realises they have grown distant from their community of origin, yet have not been fully accepted in the destination community (Castles et al., 2014). In this suspended space, the decision to return sometimes takes on a motivation other than the economic one, not necessarily because home is better, but because it is the place where you know who you are.

Taken together, the quantitative and qualitative data outline a social cost of migration that far exceeds depopulation statistics, it is found in fractured family relationships, in uncertain identities, and in communities that age without knowing how to renew themselves (UNDP Moldova, 2020).

Migration and Return Intentions

The intention to leave remains present in the communities of southern Moldova, and the data leave no doubt as to the reasons. Economic factors dominate, but the picture is more nuanced than a simple search for a higher salary: respondents speak of quality of life, infrastructure, and professional prospects that the country of origin does not yet offer. Migration is no longer perceived as an emergency solution, but as a rational option for a better life, which makes it all the harder to counter through targeted public policies.

When it comes to return, the picture becomes more complex. Asked whether they believe migrants will come back, population respondents are almost evenly split: 41.98% believe they will, 33.21% believe they will not, and 24.81% do not know (Figure 2).

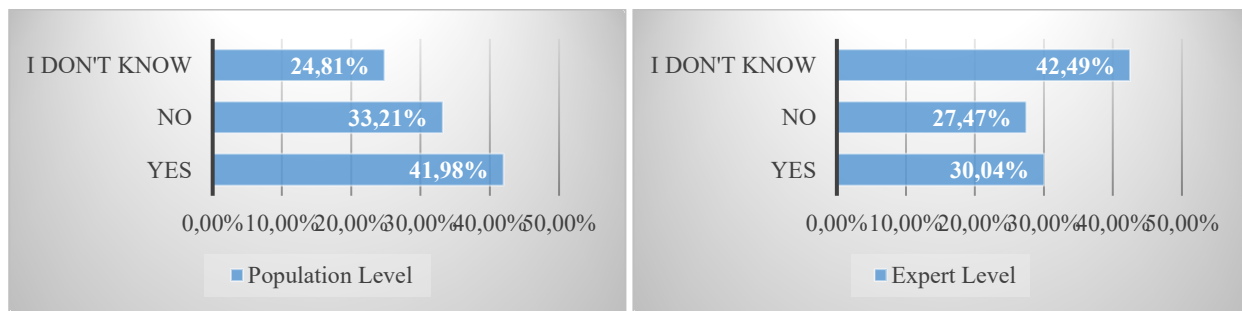


Figure 2. Respondents' Perception Regarding the Return of Migrants

Source: elaborated by the author based on data from the sociological survey conducted (population level and expert level)

Experts are even more cautious: only 30.04% consider return likely, 27.47% rule it out, and 42.49%, the largest share respond that they do not know. This uncertainty is not indifference; it reflects a reality that experts know from practice, return depends on too many simultaneous factors for anyone to predict it with certainty.

The interviews explain the mechanisms behind these figures. The decision to return rarely appears as spontaneous; it is generally planned, negotiated as a couple or within the family, and conditional on the achievement of concrete objectives: *"We, before coming back to the Republic of Moldova, two years before, had planned it... we decided we would stay two more years and then return home."* (Maria, 33 years old, Germany, returned after 5 years of migration)

This logic is perfectly consistent with the NELM framework, return as a planned stage of a migration project with clear objectives (Stark, 1991), and with Cassarino's (2004) typology, which distinguishes between prepared returnees, with mobilised resources, and those forced by circumstances. Maria belongs to the first category, and her testimony suggests that this category exists in southern Moldova as well, even if it is not the majority.

The factors that keep migrants away are, however, stronger than those that bring them back. The financial stability and comfort accumulated over years of work abroad create an inertia that is difficult to overcome: *"Financially, it motivates you to stay there."* (Rita, 35 years old, Austria, 10 years in migration) *"The financial situation, certainly... for improving quality of life, plans that cannot be realised here."* (Austina, 32 years old, Alaska, returned 5 years ago)

Experts add a temporal dimension to this dynamic, the longer the migration lasts, the less likely return becomes. Social and professional integration in the host country is not an automatically reversible process: *"After five years, a situation already arises where the person is practically fully settled and integrated, and their return to the country of origin becomes very unlikely."* (interviewed expert, ReMiReM project)

This observation is also supported by the specialized literature: de Haas and Fokkema (2011) demonstrate that integration into the host society and the building of local social networks significantly reduce the intention to return, regardless of attachment to the country of origin. In other words, it is not that people forget about home, it is that the life built there becomes too concrete to be abandoned.

To this is added a shift in expectations that experts observe from the front line: *"People are now orienting themselves towards a better quality of life there... a more decent standard of living, with more developed infrastructure."* (interviewed expert, ReMiReM project)

The differences in infrastructure and public services between Moldova and destination countries are no longer perceived as temporary, they have become a benchmark against which Moldova is evaluated and found lacking. This explains why return, when it does occur, often has a circular rather than definitive character: *"The circular, pendular kind predominates, you know? They leave, they come back, they leave, they come back."* (interviewed expert, ReMiReM project)

Circular migration is not a failure of retention policies, it is a rational adaptation to a context in which Moldova offers enough for a visit, but not enough for a permanent stay (King, 2000; Hachi et al., 2021). Understanding this logic is essential for any strategy aimed at attracting returnees: it is not enough to make conditions tolerable, they must be made competitive.

Conclusions

Migration from southern Moldova operates according to a well-known logic: it brings money into homes and empties villages. The research data confirm this dual character, real economic benefits at the household level, profound social costs at the community level, and show that local public administration experts, those who manage the consequences on a daily basis, are considerably more critical of the phenomenon than the general population 63.74%, a weighted majority).

The return of migrants is neither spontaneous nor guaranteed. It is planned years in advance, conditional on clear economic objectives, and progressively weakened by integration into the host society. After five years abroad, the probability of permanent return decreases significantly, which explains why circular migration remains the dominant form in the region. Differences in wages and infrastructure are not perceived as temporary, but as a benchmark against which Moldova is systematically evaluated.

Children left behind represent the most invisible and hardest to recover cost of this phenomenon, separations of 5 to 7 years with documented emotional consequences, evidenced in both quantitative data and interview testimonies.

On the basis of these findings, the research formulates five priority directions for action: leveraging remittances through productive investment mechanisms; creating institutional liaison structures with the diaspora to facilitate planned return; sustained investment in rural infrastructure and the local labour market; expansion of social services for migrant families, with a focus on psychological and educational support for children; and the institutionalisation of periodic mixed-method research on the migration phenomenon at the regional level, as a foundation for evidence-based public policies.

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CRITERIA FOR INDIVIDUALIZATION AND DELIMITATION OF CITIES IN THE NORTH DEVELOPMENT REGION

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Abstract *The North Region possesses the largest number of small and medium-sized towns among the development regions of the Republic of Moldova, including 3 municipalities and 17 towns. Currently, the urban network of the North Development Region (RD Nord) is characterized by a polycentric structure, in which the municipality of Bălţi represents the main polarizing growth center, followed by urban centers with secondary regional functions. The emergence and evolution of these urban centers have been influenced by a series of political, economic, and social factors. Small and medium-sized towns perform economic, social, and administrative functions within the human settlement network. However, in the absence of coherent development strategies and due to the manifestation of unfavorable socio-economic factors, most human settlements in the region face demographic and economic challenges, which have contributed to an accentuated urban decline. The purpose of this study consists of analyzing the criteria for individualizing and delimiting the towns of the North Development Region by evaluating their territorial, social, and economic dynamics, as well as the evolution of urban functions in the context of regional transformations. The research is based on quantitative analysis methods used to identify the causes of urban stagnation, improper management, and the insufficiency of strategic planning. The study's results can contribute to the substantiation of regional and urban development policies, serving as a useful tool for local and regional decision-makers.*

Keywords: *city/town, urban settlement, administrative boundary, urban centers*

JEL: R11, R12, R58

Introduction

A city is an administrative-territorial unit that is more economically, socially, and culturally developed than a village. It encompasses an urban population and features corresponding municipal, industrial, and commercial structures. The majority of its population is employed in industry, public services, various fields of intellectual activity, and in cultural and political life. [1]

Small and medium-sized towns play an important role in the network of human settlements through the economic, social, and administrative functions they fulfill. The dynamics of these territorial entities constitute a complex process, marked by their positioning at the intersection of important trade routes, by industrialization policies, and by socio-economic restructuring. Currently, the urban network of the Northern Development Region (RD Nord) is distinguished by a polycentric structure, with the municipality of Bălţi serving as a polarizing growth center, followed by regional centers with a secondary degree of polarization. The purpose of this study is to analyze the dynamics of these settlements from a territorial, social, and economic perspective, highlighting the way in which their functions have evolved over time in accordance with the transformations that have taken place in this space.

Urban physiognomy is a product of the evolution of human settlements, governed by factors of varying spatial, political, and socio-economic intensity. Within the general framework, the city is a component of the habitat system, yet it plays a well-defined structuring role at the spatial level. On a global scale, cities have exhibited territorial and demographic functionalities and redistributions that

have contributed to the current geographical configuration of the world and its peoples, while enhancing the overall quality of life.

Concerns regarding the study of cities date back to antiquity; essential contributions were made by ancient philosophers such as Strabo, Hippocrates, Plato, Ptolemy, and others. The first systemic appraisals of urban areas are found in the works of Alexander von Humboldt, specifically in his work *Views of Nature* (1808) [12], and Karl Ritter, in his work *Die Erdkunde* (The Science of the Earth) [13]. Friedrich Ratzel is considered the father of social geography; in his work *Antropogeographie* [14], he proposed for the first time at a scientific level the theory of "living space" (*Lebensraum*), defining the notion of the *ecumene* as the habitable part of a people that provides terrestrial and expansion rights based on their type of activity or military decisions. This theory confirmed the hypothesis of the influence of natural factors and geographical position on the morphostructure of cities. In the mid-20th century, Walter Christaller (1893–1969) observed the position of urban habitats in relation to rural ones as being hierarchically superior, occupying a central position that governs the surrounding space. This theory was named the **Central Place Theory**.

The human factor was not excluded from this context. Practically, an indissoluble relationship manifests between man and his place of residence; through their lifestyle and types of activities, humans shape natural landscapes and directly influence ecological systems. The highly complex dynamism of urbanization has been observed as a phenomenon starting from the middle and toward the end of the last century, marked by intense population movements toward cities. This generated a complex urban system and, simultaneously, highlighted the functionality of cities as a primary factor in industrial and socio-economic development.

The evolution of cities is approached from both an intra-urban and inter-urban perspective. At the **intra-urban** level, the city is studied from a functional perspective—specifically, the interaction between population flows and the site where the city developed. In other words, this refers to the **urban morphostructure**. From an **inter-urban** point of view, the focus is on the alignment of a city's fundamental concepts in relation to the broader urban system.

Criteria for Urban Individualization

The city represents the most expressive image of society, concentrating the most precious assets created by man. [6] Over time, a multitude of definitions regarding the significance or meanings of the term "city" have been proposed. In his work *Antropogeographie*, Friedrich Ratzel attributes to the city a substantial surface area with a minimum number of inhabitants, situated at the intersection of communication routes. Jean Brunhes, in his work *La Géographie Humaine* (Human Geography, 1910), and Pierre Defontaines in *L'Homme et l'habitat* (Man and Habitat, 1953), consider that a city exists whenever the majority of its inhabitants spend their time within the agglomeration. Ferdinand von Richthofen views the city as a grouping of people whose primary activities are non-agricultural. On the other hand, H. Wagner considers cities to be concentrated points of human trade. According to author Vasile Cucu in his work *The Geography of Cities* (1970) [11], several basic criteria are essential in defining urban areas, namely: geographical position, demographic size, professional structure, and economic potential.

From all these conceptions put forward over time, we can conclude that the city represents a form of organization comprising the following components:

- a) **Natural framework** (soil and subsoil components)
- b) **Population**
- c) **Built environment** (residential areas, production and storage units, commercial units, monuments, health and cultural institutions, educational institutions, etc.)
- d) **Infrastructure** (roads and access ways, utility networks, technical equipment)
- e) **Leisure zones** (parks, plantations, recreation areas) [6]

Based on the analysis above, one can observe the so-called "urban anonymity," manifested through a high degree of cultural diversity. Mutual acquaintance among community members is quite reserved,

kinship ties are of little importance, and the population's activities can extend beyond the administrative perimeter of the city.

Criteria for the Delimitation of Cities

The granting of urban status is based on multiple criteria. However, in most countries around the world, the fundamental criterion is the population size. At an international level, it is a common practice to grant urban status to settlements with a population ranging between 5,000 and 10,000 inhabitants.

In the European Union, administrative-territorial organization is a competence assigned to the member states. This means that each country has its own criteria for granting urban status. Nevertheless, through Eurostat and the OECD, a standardized system has been created to obtain comparable statistical data from each country.

European practice is based on population grids per km². Thus, settlements are classified into cities (large urban centers) and towns and suburbs as follows:

Table 1. Criteria for the Delimitation of Cities in the EU

Settlement Type	Characteristics
Cities (Large Urban Centers)	75% population concentration 1,500 inhabitants km ² ≥50,000 inhabitants
towns and Suburbs	50% population concentration 300 inhabitants km ² ≥ 5,000 inhabitants

Source: elaborated by the author based on source [4]

A very practical phenomenon in the EU is the **FUA (Functional Urban Area)** [4], a concept used by the OECD and Eurostat to delimit a city's actual sphere of influence, rather than just its administrative boundaries. This means that urban status can also be granted to settlements that do not strictly meet the criteria listed above but represent an urban core through their capacity as a **commuting zone**. In other words, populations from adjacent settlements commute for their daily activities. This practice is frequent and attracts significant European funding. Examples of such urban areas include Île-de-France (France), Lille (Belgium), Ruhr and Duisburg (Germany), Katowice and Sosnowiec (Polonia), Szeged and Pécs (Hungary), and Chiajna, Otopeni, Popești-Leordeni, or Apahida-Clujului (Romania).

In countries with low population density due to climatic conditions, the threshold for granting urban status is even lower, both at the international and European levels. Sweden, Iceland, and Peru serve as examples of such models. In Denmark and Sweden, the population threshold can drop as low as 200 inhabitants, while in Peru and Iceland, the minimum population threshold disappears entirely, focusing instead on the degree of spatial occupancy itself—specifically, a minimum of 100 dwellings. There are also regions where even the smallest human settlements take on an urban character based on their specific commercial functionalities. Such a practice is frequently encountered in the USA and Canada.

When discussing population distribution within human settlements, it is indispensable to take into account the degree of compactness. From this perspective, the distances between buildings should be between 50 and 200 meters, while population density varies from country to country: in France, it

must be 5 inhabitants/ha, for Germany 10 inhabitants/ha, and 25 inhabitants/ha for the United Kingdom.

Table 2. Minimum population thresholds for granting urban status.

Minimum Number of Inhabitants	States / Countries
200	Sweden, Denmark
500	South Africa
1000-2000	Australia, Ireland, France, Greece, Netherlands, Argentina, Cuba, DR Congo
2500	Mexico
4000	South Korea
5000	India, Pakistan, Turkey, Austria
10 000	Republic of Moldova, Ukraine, Italy, Spain, Japan, Serbia, Montenegro, Switzerland

Source:elaborated by the author based on source [4,6]

At the international level, there is also the practice of granting urban status through political decisions, either in the form of local referendums or through individual laws. Such phenomena are found in Sri Lanka, New Zealand, Scotland, Bulgaria, and the United Kingdom. This practice is also present in Romania.

In Latin America, all administrative units that perform socio-economic and regional coordination functions are considered cities.

Criteria for the Classification of Cities

As a highly complex social and economic phenomenon, the city can possess very special structures and functionalities of particular significance to economic development, maintaining its position as a primary driver of collective population satisfaction.

Consequently, the classification of cities is based on several criteria, depending on the intended objective.

Table 3. Classification of cities according to specific criteria [6]

Criterion	Type / Category
By geographical location	Mountain cities Hill, plateau cities Plain cities Cities near hydrographic networks (Riverside/Coastal)
By genesis (origin)	Ancient Medieval Contemporary
By structure (layout)	Linear, bilinear Rectangular (Grid) Polynuclear
By appearance / morphology	European style North American style
By function	Commercial / Trading Agro-industrial University / Student cities Military Complex (Diversified)

By evolutionary form	Micro-region City / Town Metropolis Megalopolis
By demographic capacity	Small cities ($\leq 10\,000$ loc.) Medium cities ($10\,000 - 100\,000$ loc.) Large cities ($100\,000 - 1\,000\,000$ loc.) Very large cities / Megacities ($\geq 1\,000\,000$ loc.)

Source: elaborated by the author based on source [6]

The city is considered a pole of territorial coordination, meaning that it performs multiple functions. Consequently, cities can also be classified based on other criteria, such as the polarization area (sphere of influence), infrastructure, administration, public security, and others.

Table 4. Analysis criteria for granting urban status. Elaborated by the author.

Analysis Criterion	Indicators / Description
Populations	Global average of 5,000 inhabitants.
Polarization Area	Within a radius of 20–30 km (sphere of influence).
Infrastructure	Access road networks and connectivity.
Labor Market	75% of the population employed in non-agricultural sectors.
Administration	City Hall (Local Government), prosecutor's office, notary services, courthouse, justice departments.
Health	Hospital, ambulance services, pharmacies, outpatient clinics.
Trade / Commerce	Specialized stores, marketplaces.
Sports	Gyms, sports fields, stadium.
Public Utilities (Utility Infrastructure)	Water supply (aqueduct), sewerage, pumping stations, wastewater treatment plants, public restrooms, sanitation/waste management stations.
Environmental Protection	Ecological inspectorates, animal shelters.
Communications & Transport	Post office, bus station and/or railway station.
Finance	Banks, commercial banks, insurance companies.
Religion	Places of worship, cemeteries.
Education	Nurseries, kindergartens, schools, specialized schools (fine arts, music, dance).
Tourism	Travel agencies, hotels (minimum 2 stars).
Culture	Libraries, community centers (<i>culture houses</i>), art and creative centers.

Security	Police stations, gendarmerie/carabinieri, Inspectorate for Emergency Situations (IGSU/Fire Dept).
Leisure / Recreation	Parks, playgrounds.
Social Assistance	Placement centers, elderly care centers, inclusion centers.

Source: elaborated by the author based on source [6]

In the Republic of Moldova, administrative organization is coordinated in accordance with **Law No. 764 of 27.12.2001 on the Administrative-Territorial Organization of the Republic of Moldova**, which establishes the categories of administrative-territorial units. According to this provision:

"The city (town) is an administrative-territorial unit that is more economically and socio-culturally developed than the village; it encompasses the urban population, possesses appropriate public utility, industrial, and commercial structures, and its population is largely employed in industry, public services, and various fields of intellectual activity, as well as in cultural and political life." [1]

In this regard, we can distinguish that cities occupy a higher hierarchical position compared to villages through the structures and functions they perform. At the same time, cities occupy an area of economic polarization for the surrounding settlements.

Within the same legal provision, the status of **municipality** is established under the category of cities, defined as "an urban-type locality with a distinctive role in the economic, socio-cultural, scientific, political, and administrative life of the country, featuring important industrial and commercial structures, as well as institutions in the fields of education, healthcare, and culture." [1] The status of municipality is granted to the cities of Chişinău, Bălţi, Bender, Cahul, Ceadr-Lunga, Comrat, Edineţ, Hînceşti, Orhei, Sorooca, Străşeni, Tiraspol, and Ungheni. According to **Law No. 435 of 28.12.2006 on Administrative Decentralization**, it is established that cities possess autonomy in managing their own resources to satisfy community needs, aiming to enhance administrative quality and improve demographic and infrastructural indicators. [3] The competences and duties of community leaders are in strict accordance with the legal-normative framework governing city administration, in democratic consensus with local councils, which are politically formed following electoral ballots based on political affiliation or independent candidacy. [2]

The Evolution of Urban Settlements

The genesis of the first urban formations coincides with the region spanning from Northeast Africa to the Far East [6], situated along hydrographic networks. This territorial organization was due to both the requirements of waterborne transport for goods and products—serving as a communication route—and the necessity of supporting agriculture.

The first urban settlements developed along the Tigris and Euphrates rivers (Mesopotamia, considered the cradle of civilization), as well as in the Nile and Indus valleys. In mountain basins, the Persian civilization established itself, favoring the development of a pastoral economy.

The most ancient city is Petra (known in antiquity as Raqmu), which is also mentioned in the Dead Sea Scrolls and was founded in the 6th century BC. Damascus remains the oldest continuously operating capital, founded over 4,000 years ago, while Jerusalem was established in 1000 BC by the Hebrew King David on the site of a Canaanite fortress, remaining the only holy city for three major religions. [6]

In political-administrative organization, a significant role was played by cities developed in coastal areas, particularly in the Mediterranean basin, which fostered the expansion of navigation and trade. Relevant examples include the Cretan and Greek civilizations, which served as the foundation for subsequent civilizations (Roman, Phoenician). The most famous cities were Troy, Ephesus, Mycenae, Knossos, Heraklion, etc. The peak was reached during the expansion of the Roman Empire through wars of conquest, stretching from the Iberian Peninsula to Dacia Felix and Nor The oldest cities in

Romania date back to the 7th century BC and were concentrated on the Black Sea coast: Tyras, at the mouth of the Dniester; Istros (Histria); Tomis (Constanța); and Callatis (Mangalia). These cities functioned as city-states. There were also cities of civil-military cohesion known as *davae*: Ziridava (Pecica), Petrodava (Piatra Neamț), Cumidava (Râșnov), Buridava (Ocnița), and Pelendava (Craiova).

The Historical Evolution of Cities in the North Development Region

In ancient times, Moldavia was divided into three parts: the Lower Country (*Țara de Jos*), the Upper Country (*Țara de Sus*), and Bessarabia, which together comprised 23 smaller districts [7, p.20] The Lower Country included 12 districts, covering part of the current territory of northern Moldova; the Upper Country included 7 districts, and Bessarabia was considered the "forefront" (*partea de frunte*) of Moldavia.

Urban settlements on the archaic territory of the Republic of Moldova are documented during the Middle Ages under the phrase *târguri* (market towns), a term derived from the Slavic word *trugu*. The term *oraș* (city/town) has its roots in the Hungarian word *város* and became popular in this region during the 14th century. [5, 10, GIURESCU C.C]

Urban fortifications were built depending on the geographical position of the locality or the nature of human activity. However, the primary role in the genesis of urban settlements belonged to the citadels, which asserted their importance through the presence of fortresses or fortifications. [5]

During the medieval period, the most significant urban centers with economic impact were Old Orhei (*Orheiul Vechi*), Hansca (Costești, Ialoveni District) [5, 9], and the small market town of Scerbanca, which later ceased to exist. [5, 9]

At the end of the 15th century, the urban complex comprised 17 cities, four of which were located in the territory between the Prut and Dniester rivers: Cetatea Albă, Chilia, and Sărata. In the 16th century, three more urban centers appeared: Cernăuți, Hotin, and Orhei. [5, 9]

The 18th century was marked by the work of the greatest chronicler, politician, and philosopher—Dimitrie Cantemir. His fundamental work, which includes a detailed description of this territory, is *Descriptio Moldaviae*. [7] According to Cantemir's records, cities were divided into three categories:

- **Fortified Cities (Fortress-Cities):** Hotin, Soroca
- **Market Towns (*Târguri*):** Lăpușna, Orhei
- **Small Market Towns (*Târgușoare*):** Chișinău

It was specifically in the **18th century** that the development of cities in Bessarabia reached its peak with the emergence of market towns (*târguri*), especially in the Northern region.

Thus, the market town of **Bălți** was founded in 1769, followed by **Atachi (Otaci)** in 1781. The market town of **Lipcani** emerged due to the commercial route within the Iași–Hotin–Botoșani economic triangle. **Briceni** appeared as a market town in 1788, and **Telenești** in 1795. The first historical records of **Soroca** were documented in a charter signed by Prince Stephen the Great on June 29, 1499, as a land grant to the burgrave (*pârcălab*) Coste; the settlement was then named *Alchionia*. During the reign of Alexander the Good, on June 15, 1431, the Veadinți district—today's city of **Edineț**—was granted to the boyar Cupcici. Due to the clayey soil and climatic conditions that created heavy mud (*glod*), the settlement on this land was named **Glodeni** in 1673. The youngest city in the North Development Region is **Ocnița**, which was once a small village on the banks of the Dniester. It received city status in 1897, following the construction of the railway hub at the junction of commercial routes on the country's northern border.

The events following **1812** were marked by the cession of the Principality of Moldavia and the occupation of this territory by the Tsarist regime. During this period, the so-called "*posads*" (suburbs/trading settlements) emerged. Thus, under the rule of the Russian Empire, seven cities, three *posads*, and two market towns stood out, organized according to the following structure:

- **Capital City** (referring to Moscow)
- **Gubernatorial City** (Chișinău)

- **County Seat / Residence City** (Bălți, Soroca, Hotin)
- **Non-residence City** (Cahul, Chilia) [5]

At the beginning of the 20th century, Bessarabia reunited with Romania. Historical records mention that on the territory of Bessarabia, there were 9 county seats and 49 market towns (*târguri*). [1, 8] The registration of such a high number of market towns highlights the significant growth of commercial activities and the fact that cities were increasingly becoming both economic and administrative centers. [8]

In 1925, the **Law on the Administrative Unification of Romania** was passed. The effects of this law extended to the territory between the Dniester and Prut rivers. Thus, from an administrative perspective, the territory was organized into counties (*județe*). Consequently, by 1930, there were 20 cities and 3 municipalities on this territory: Chișinău, Bălți, and Cetatea Albă. The distribution was carried out by including several cities within a county, according to the following structure:

- **Bălți County** – the cities of Bălți and Făleşti
- **Cahul County** – Cahul and Leova
- **Cetatea Albă County** – Cetatea Albă and Tuzla
- **Hotin County** – Hotin and Noua Sulița
- **Ismail County** – Ismail, Bolgrad, Chilia, Reni, and Vâlcov
- **Orhei County** – Orhei and Rezina
- **Soroca County** – Soroca
- **Tighina County** – Tighina and Comrat

With the formation of the Moldavian SSR, urban settlements developed in accordance with the legislative and economic changes that took place. This period is characterized by increased economic progress generated by industrial development. In practice, there was an explosion of industrial complexes specialized in specific production fields, such as agriculture—including livestock farming, viticulture, and fruit growing—or production and consumer industries, such as the food or sugar industries. Heavy industry played a special role, as it covered energy market distribution and the construction sector.

Consequently, alongside this surge in economic progress, new towns emerged. In 1976, the town of **Costești** was established, built near the Costești-Stâncă Hydroelectric Power Station. The town of **Ghidighici** was founded in 1963 near construction material production plants. In 1964, the town of **Dnestrovsc** was established on the Left Bank of the Dniester, adjacent to the Moldavian Thermoelectric Power Station. Near sugar production plants, several towns were founded: **Cupcini** (Edineț) in 1964, **Biruința** (Sîngerei) in 1965, **Frunze** (Ocnița) in 1946, and **Ghindești** (Florești) in 1956. [5]

During the Soviet period, the typology of urban settlements included the concept of **urban-type settlements**, also known as small towns or worker's settlements, which occupied an intermediate position between a city and a village. To obtain this status, these localities were required to have a population exceeding 500 inhabitants, primarily consisting of workers from *sovkhozes* (state farms). Between 1950 and 1980, the share of urban-type settlements exceeded 50% of the total number of urban localities.

Following the 2021 reform, the administrative-territorial organization is divided into 33 districts and 65 cities (20 of which are located in the North Development Region). Among these, 7 hold the status of **municipality**: Chișinău, Bălți, Tiraspol, Bender, Comrat, Edineț, and Ungheni.

Conclusions

The city represents a heterogeneous administrative unit, with diverse populations—both native and migrant—who relate to distinct social values. Ensuring high-quality urban living is a fundamental and highly complex necessity, requiring the active commitment of both political and administrative actors.

Structurally, urban areas are characterized by an immense concentration of habitats, which often limits free access to ecological resources. Therefore, quality standards require constant monitoring to remain sustainable.

On the archaic territory of the Republic of Moldova, urban settlements were first documented during the Middle Ages under the term *târguri* (market towns). With the formation of the Moldavian SSR, urban settlements developed through economic progress driven by industrial expansion. Notable examples include the towns of **Cupcini** and **Glodeni** (sugar industry), and **Ocnîța** (railway hub and canning industry), among others.

The increasingly accelerated process of urbanization emphasizes the creation of an urban image that passes through both the subjective filters of individual trust and the objective perspectives of the entire community.

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RECENT DEMOGRAPHIC TRANSFORMATIONS IN THE PRUT RIVER BASIN DURING THE 2014-2024 PERIOD: CHALLENGES AND OPPORTUNITIES

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Abstract: *This paper analyzes the demographic dynamics within the Prut River hydrographic basin over the 2014-2024 decade, frameworked by the "Siret-Prut-Nistru" and "Lower Danube" Euroregions. The study aims to identify evolutionary trends in population size, age structure, and natural movement indicators across riparian localities. The methodology integrates comparative analysis, statistical methods, and GIS cartographic representation, relying on official usual residence data and census results provided by BNS and INS. The findings reveal severe depopulation, with rural population decline exceeding the critical threshold of 30%. Structural analysis highlights pronounced demographic ageing (mean age >40 years) and a massive productive exodus, phenomena that directly jeopardize the socio-economic sustainability of critical utility infrastructure (water and sanitation). Ultimately, the study underscores strategic opportunities driven by cross-border cooperation, smart water management, and eco-tourism to stabilize and retain regional human capital.*

Keywords: *hydrographic basin, population dynamics, demographic ageing, critical infrastructure, Prut River.*

JEL: J11, R11, Q56.

Introduction

The Prut River Basin is a strategic cross-border area on the eastern border of the European Union, covering an area of approximately 8,250 km² (24.4% of the country) on the territory of the Republic of Moldova. Integrated resource management is integrated in the Danube-Prut and Black Sea District, the region being essential for cohesion policies within the "Siret-Prut-Nistru" and "Lower Danube" Euroregions ("Siret-Prut-Nistru" Euroregion, 2023). The current configuration of settlements in this hydrographic space reflects a close historical interdependence between water resources and the dynamics of riparian human communities (Chirică and Bejan, 2009).

In the decade 2014–2024, the area has experienced radical demographic transformations. The confluence of chronic natural decline, massive emigration of the active population and socio-economic restructuring has triggered a severe contraction of human capital. The sharp depopulation deeply affects rural localities in the vicinity of the Prut riverbed, an evolution statistically highlighted by applying the usual residence indicator to the detriment of the scriptical population (BNS, 2025). This dynamic represents a systemic vulnerability that directly undermines the sustainability of public investments and water supply systems provided for in national strategies (Ministry of Infrastructure and Regional Development of the Republic of Moldova, 2022).

This research analyzes the spatial-temporal disparities of population, age structure and natural movement in riverside localities. Based on official data on structural dynamics (BNS, 2024), the study applies a methodology focused on comparative analysis and cartographic modeling. The aim of the work is to quantify the structural decline and to identify cross-border financing solutions — using the axes of the European programs for smart water networks — in order to capitalize on human potential in sustainable development and eco-tourism projects (Interreg Next Cross-Border Program Romania-Republic of Moldova, 2024).

Methodology and data sources

The research on demographic evolution in the Prut basin is based on data from the National Statistical Office (2024) and the National Institute of Statistics (2024). For comparability, indicators were extracted from the 2004, 2011 (INS, 2013) and 2014 (NSO, 2016) Censuses, supplemented with current estimates (2014–2024). The methodology replaces the stable population with the “usual resident” (USR) population according to international standards (UNECE, 2015), correcting for migration distortions (Gogu, 2021) for persons present for at least 12 months. The indicators cover dynamics, age groups (0–14, 15–59, 60+), average age, natural increase and ageing (Ghenea and Matei, 2018; Penina, 2020).

Data processing integrates the following methods (Muntele, 2010):

- Comparative analysis: Highlights the rhythms of depopulation and territorial structural gaps (Benedek, 2004), revealing patterns of urban and rural contraction.
- Statistical-mathematical methods: Used to calculate the aging, dependency and percentage variation indices (Ghenea and Matei, 2018).
- Cartographic and GIS method: Implemented for the spatialization of indicators at district level (Grozavu and Pleșcan, 2015), identifying critical areas and resilience poles in the “Siret-Prut-Nistru” and “Lower Danube” Euroregions (Savu and Dumitru, 2019).

Analysis of demographic population indicators (2014–2024)

Rural population dynamics: Decline and “desertification” of riverside localities

According to the final results of the 2024 Population and Housing Census (PHC), the population of the Republic of Moldova has undergone profound transformations in the last decade (BNS, 2026). The numerical contraction affects the entire Prut basin, but with different territorial intensities. Unlike the moderate decline in the period 1989–2009, the decade 2014–2024 is marked by a steep collapse of the population with usual residence (Chirică and Bejan, 2009; BNS, 2025). The districts in the northern sector of the basin, especially Briceni and Edineț, record the highest depopulation rates, exceeding the critical threshold of 15–20% in some localities in just ten years.

Table 1: RURAL population dynamics in the 12 districts of the Prut Basin (2014–2024)

Nr.	District	Number in 2014 (RPL)	Number in 2024 (Est. BNS)	Variation (%)
1	Briceni	62.729	44.300	-29,4%
2	Ocnîța	30.125	21.200	-29,6%
3	Edineț	41.500	29.800	-28,2%
4	Glodeni	41.006	28.500	-30,5%
5	Fălești	66.400	45.300	-31,8%
6	Ungheni	70.264	47.600	-32,3%
7	Nisporeni	41.400	29.200	-29,5%
8	Hîncești	88.335	59.500	-32,6%
9	Leova	37.424	25.600	-31,6%
10	Cantemir	48.715	34.700	-28,8%
11	Cahul	75.324	45.800	-39,2%
12	Rîșcani	55.400	39.800	-28,2%
Total Bazinul Prut (Rural)		658.602	451.300	-31,5%

Data source: statistica.gov.md - Population with usual residence (National Bureau of Statistics, 2024)

The data in Table 1 reveal a severe demographic contraction in the Prut River Basin (2014–2024), defined by the following coordinates:

- Dimension of the decline: The rural population of the basin has generally decreased by over 31.5% (BNS, 2025).
- Critical area: Cahul (-39.2%) and Hincesti districts record the largest absolute losses, indicating a profound destructuring of the communities in the Lower Prut (Bacāl and Țugulea, 2024).
- Central sector: In Ungheni (-32.3%) and Hincesti (-32.6%), the decline is accelerated by the combined pressure of internal migration and cross-border commuting (Muntele, Grozavu and Roșu, 2018).
- Determinisms: Over 80% of this deficit is caused by external migration of the 20–40 age group, a phenomenon that eliminates productive and reproductive capital, while negative natural growth accentuates the trend (Gogu, 2021).
- Geographical and socio-economic impact:
- Infrastructure: The low population density compromises the financial sustainability per capita of new water and sewage networks (Interreg Next Romania-R0M Cross-Border Program, 2024).
- Agriculture: Depopulation and lack of generational succession block the exploitation of irrigation systems and the survival of local farms (Bacal and Burduja, 2018).
- Public services: The decrease in the number of beneficiaries requires the optimization of proximity institutions (schools, medical points), accelerating the exodus of the remaining population (Ministry of Infrastructure and Regional Development of the Republic of Moldova, 2022).

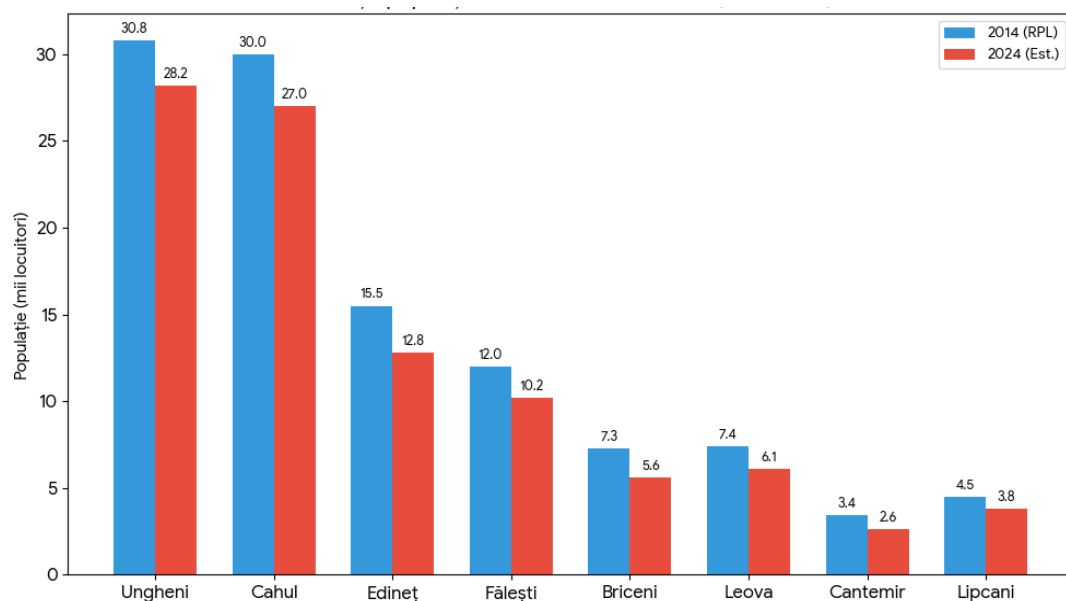


Figure 1. Urban population dynamics in the Prut River basin (period 2014-2024).

*Source: Prepared by the author based on data from the National Bureau of Statistics
 (RPL 2014 and Population with Usual Residence 2024).*

The analysis of urban centers in the Prut basin (2014–2024) highlights a generalized demographic contraction of the population with usual residence, but with major disparities determined by the capacity for economic polarization.

Ranking	Example cities	Population 2024 (Est. RPL)	Trend
Regional Poles (>20 thousand)	~30-35 thousand	~30-35 mii	Moderate decline, resilience
Small Cities (10-20 thousand)	~10-12 thousand	~10-12 mii	Severe decline
Agro-industrial Cities	<10 thousand	<10 mii	Critical depopulation

Large cities (Ungheni, Cahul) show structural resilience due to their administrative, industrial and university functions. They retain a critical mass of over 20,000 inhabitants, limiting the decline to 8-10%. In contrast, medium-sized cities (Briceni, Edineț, Făleşti) record a much steeper decline curve, losing human capital at an accelerated rate and reducing their role as support poles for the rural hinterland.

The critical situation is evident in small cities (Cantemir, Lipcani), which fall below the minimum thresholds of demographic safety. In these localities, maintaining social infrastructure and public services becomes financially unsustainable due to high operating costs per capita.

Table 2. Dynamics of the population with usual residence in representative cities and districts in the Prut River basin (2014-2024)

Administrative-territorial unit / Urban node	Population (2014)	Population (2024)	Absolute decrease (people)	Decline rate (%)	Demographic typology / Functional impact
Ungheni Municipality (Large urban center)	30.800	27.950	-2.850	-9,2%	Regional resilience zone; retains critical mass.
Cahul Municipality (Large urban center)	28.700	25.900	-2.800	-9,7%	University and administrative pole; moderate decline.
Edineț City (Medium urban center)	15.500	12.950	-2.550	-16,4%	Structural contraction; loss of support function.
Făleşti City (Medium urban center)	12.100	10.050	-2.050	-16,9%	Steep decline; reduction of active labor force.
Briceni City (Medium urban center)	7.300	5.950	-1.350	-18,5%	Severe decline in the northern sector; aging.
Cantemir City (Small urban center)	3.450	2.600	-850	-24,6%	Critical threshold; expensive public services per capita.
Lipcani City (Small urban center)	4.450	3.300	-1.150	-25,8%	Critical safety threshold; major risk of urban collapse.
Rural Environment (Cahul/Cantemir)	84.300	56.800	27.500	>-30,0%	Acute human desertification; ghost points in the meadow.

Source: Prepared by the author based on data from the National Bureau of Statistics of the Republic of Moldova (RPL 2014, RPL 2024).

The comparative population visualization (Figure 2) highlights the generalized nature of the demographic regression, with no administrative unit in the Prut basin registering increases or stagnation. The difference between the values of 2014 and 2024 represents the active labor force that left the region. While water resources remain constant, the critical mass of users necessary to justify investments in treatment and irrigation is rapidly decreasing (Bacal and Burduja, 2018). In the context

of the "Siret-Prut-Nistru" Euroregion, the dynamics suggest the need for a common labor force planning to compensate for depopulation through digitalization (Euroregion "Siret-Prut-Nistru", 2023).

The pace of decline is not uniform, but affects all the areas analyzed:

- Cahul (-39.2%): Records the largest rural demographic shock, indicating an extreme vulnerability of the villages in the southern sector (Bacāl and Țugulea, 2024).
- Hîncești (-32.6%) and Ungheni (-32.3%): The massive losses in these large districts demonstrate that proximity to strong urban centers could not stop the rural exodus.
- Briceni and Rîșcani (~28–29%): In the northern sector, although the percentages are slightly lower, the contraction is critical for the local economy because the population base was already reduced (BNS, 2025).

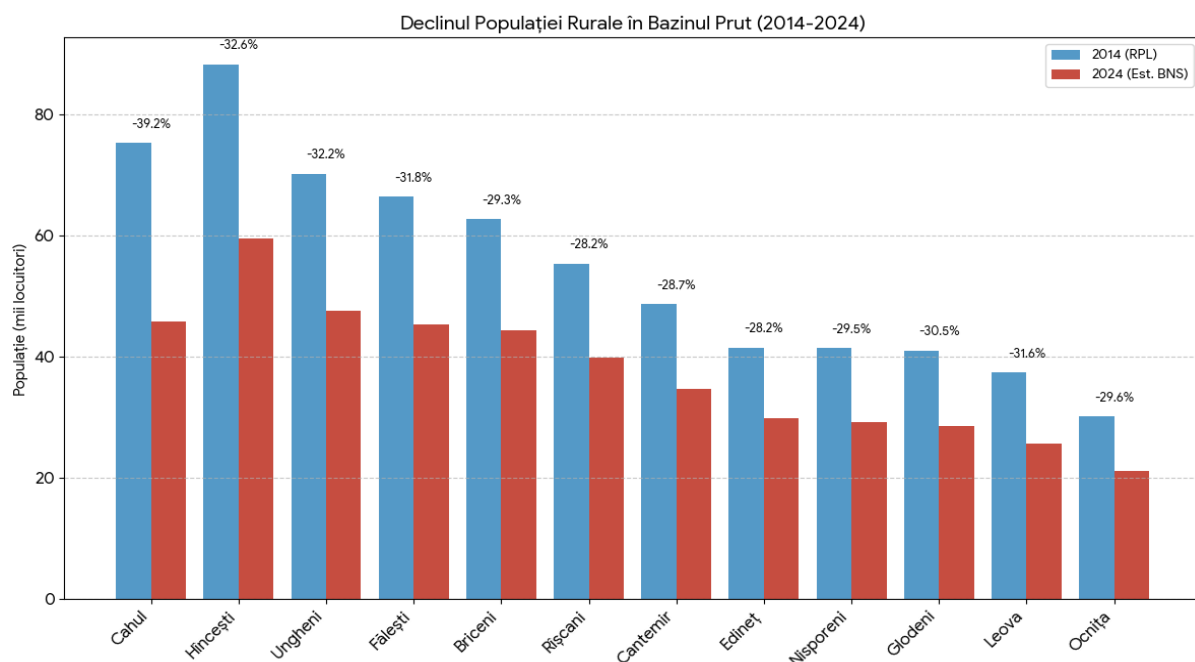


Figure 2. Urban population dynamics in the Prut River basin (period 2014-2024) .

Source: Prepared by the author based on data from the National Bureau of Statistics (RPL 2014 and Population with Usual Residence 2024).

Age structure and demographic aging process

The analysis of the age structure in the 12 districts of the Prut basin reveals an alarming transition towards a senescent type structure, indicating a structural biological decline.

The dynamics of the main age groups highlight:

- The youth group (0-14 years): It fell below the critical threshold of 17-18%. The reduction of the school quota in the villages of Glodeni and Fălești determines the migration of young families to Ungheni or Cahul, canceling the rural rejuvenation resource.
- Adult and active group (15-59 years): It constitutes 58-60% of the total, being marked by a "productive exodus". The labor force in the "Siret-Prut-Nistru" Euroregion migrates massively to the logistics centers in Iași or the European Union, generating a severe shortage of qualified personnel.
- Elderly group (60+ years): It exerts increased socio-economic pressure, exceeding the share of 25% in the northern districts (Briceni, Ocnița). In the Prut meadow, the structural ratio reaches 1.5 elderly people per single child, an indicator of an irreversible biological decline.

The increase in the average age above the 40-year threshold confirms the senescent character of the region. Spatial disparities show a considerable advance of aging in the North sector, while the Center and South sectors maintain a fragile demographic resilience, strictly dependent on the urban poles of Ungheni and Cahul. These territorial gaps are quantitatively detailed in the table below.

Table 3. Population structure by age groups and demographic aging index (RPL 2024 estimates).

District / Region	Age group 0-14 years (%)	Age group 15-59 years	Age group 60+ years (%)	Aging Index *	Profile and structural impact
1. Briceni (Nord)	15,8%	58,2%	26,0%	1,64	Critical degradation; the most severe age imbalance.
2. Ocnița (Nord)	15,4%	57,9%	26,7%	1,73	Profoundly senescent structure; chronic shortage of young people.
3. Edineț (Nord)	16,1%	59,1%	24,8%	1,54	Advanced aging; rapid contraction of the school group.
4. Rîșcani (Nord)	16,3%	59,5%	24,2%	1,48	Structural decline; high pressure on medical systems.
5. Glodeni (Centru)	16,5%	59,3%	24,2%	1,46	Above-average aging; shortage of young people in the meadow.
6. Făleşti (Centru)	17,2%	59,8%	23,0%	1,33	Trend of regression; massive exodus of the active group 15-39 years old.
7. Ungheni (Centru)	18,2%	61,3%	20,5%	1,12	The most resilient district; the urban mass tempers the decline.
8. Nisporeni (Centru)	17,9%	60,8%	21,3%	1,19	Moderate resilience; fragile balance between generations.
9. Hîncești (Sud)	17,6%	60,1%	22,3%	1,26	Stable external migratory pressure on the adult group.
10. Leova (Sud)	17,3%	59,0%	23,7%	1,37	Demographic restructuring; risk of collapse in the school network.
11. Cantemir (Sud)	16,8%	58,8%	24,4%	1,45	Rural structural collapse; heightened vulnerability.
12. Cahul (Sud)	17,5%	59,4%	23,1%	1,32	Regional pole; the municipality supports the group 15-59 through students.
Basin Average	17,2%	59,6%	23,2%	1,35	Aging pool; undermined reproductive base.

Source: Author's calculations based on usual residence data (NBS, RPL 2024 results).

The socio-geographical impact of senescence

This regressive structure has direct implications for flood risk management: an elderly population is much more vulnerable to natural hazards and requires much more complex civil protection protocols. At the same time, the low share of young people below 17% portends a severe deficit in entering the labor market for the next decade. In the absence of a policy to attract young people back to poles such as Cahul or Ungheni, the Prut river basin risks becoming a transit space managed by a third-age population, dependent on social assistance and foreign remittances.

Age Structure Analysis (Regressive Pyramid)

The graphic analysis of the demographic structure through the age pyramid reveals a profound mutation in the Prut basin. The transition from the 2004 relative stabile base to the 2024 regressive model (BNS, 2026) is characterized by:

Narrowing of the base (0–14 years): Low birth rates and family migration erode the base of the pyramid, generating a critical deficit of generational replacement in the meadow (Muntele, Grozavu and Roșu, 2018).

Migration "gap" (20–45 years): The "strangulation" of the adult segment reflects the massive exodus of the labor force (Gogu, 2021). Gender asymmetry (men in construction/technical sectors in the EU, women in services) weakens the social structure.

Bulging of the top (60+ years): The expansion of the upper segment is dominated by women, against the background of male excess mortality (Penina, 2020), overloading social assistance in the "Siret-Prut-Nistru" Euroregion ("Siret-Prut-Nistru" Euroregion, 2023).

The "urn-shaped" pyramid confirms biological decline (Muntele, 2010). Cross-border strategies 2030–2050 can no longer rely on labor market growth (Ministry of Development, 2022), requiring a reorientation of axes towards:

Automation of agriculture and water management (Interreg Next Cross-Border Program, 2024);

Adaptation of public services for an aging population (Ministry of Infrastructure, 2022).

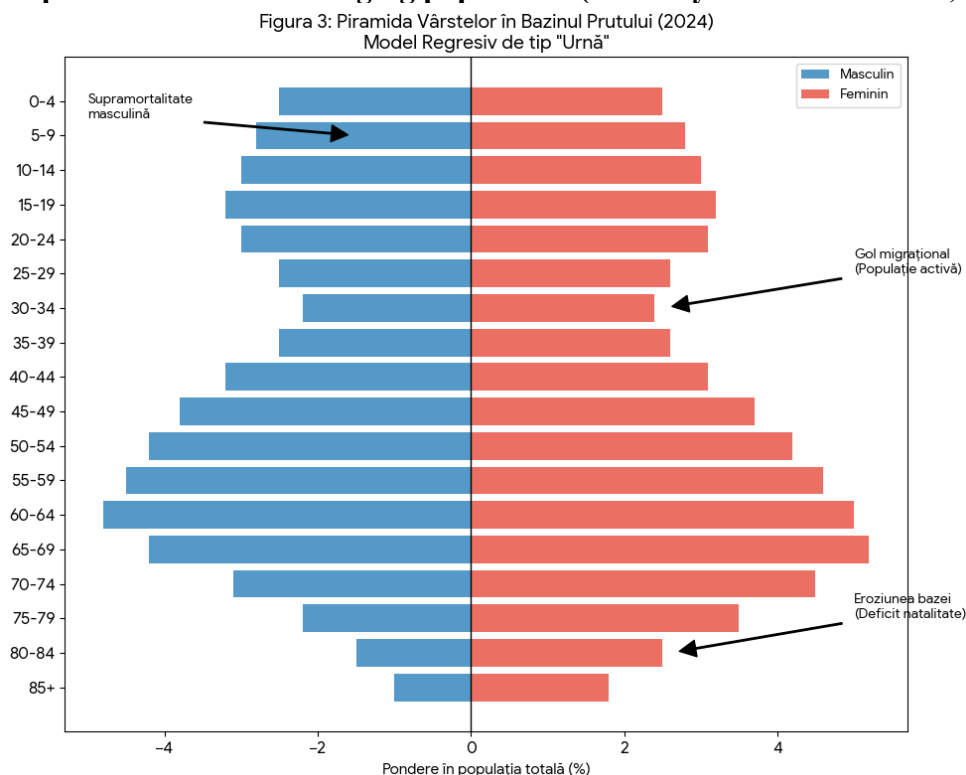


Figure 3. Population pyramid with usual residence in the Prut river basin: Structural transition from the mature profile (2014) to the senescent "urn" profile (2024)

Source: Developed and mapped by the author based on data from the Population and Housing Census (RPL, 2014) and structural estimates of the National Bureau of Statistics of the Republic of Moldova (BNS, 2025).

"Urn" Shape: The base of the pyramid (0-14 year old groups) is visibly narrower than the middle, confirming that the number of births no longer ensures the replacement of generations. **Migration "Strangulation":** A retraction is observed in the 25-40 year old age groups, the most dynamic segment, which left the region for opportunities in the EU. **Upper Asymmetry:** The top of the pyramid (75+) is much "wider" on the right (female) side, highlighting the phenomenon of feminization of old age, with major social implications for isolated rural localities.

Migration: The engine of transformations in Euroregions

Migration is the main factor in the remodeling of human dynamics in the "Siret-Prut-Nistru" and "Lower Danube" Euroregions, manifesting itself through:

Transition to family migration: Unlike the previous decade, the period 2014–2024 is marked by the complete departure of families. This phenomenon explains the severe contraction of the school population in districts such as Făleşti or Leova (Bacăl and Țugulea, 2024).

Cross-border commuting: The geographical proximity to Romania facilitates pendular migration. Many residents of Ungheni or Cahul work daily in the neighboring counties of Iași or Galați (Muntele, Grozavu and Roșu, 2018).

The paradox of remittances: The money transferred exclusively supports household consumption, but cannot compensate for the acute labor shortage in large utility infrastructure projects (Government of the Republic of Moldova, 2021).

The "Brain Drain" phenomenon: The exodus of qualified young people from university centers (Cahul) to Romania or EU states weakens the local administrative capacity to access and implement European projects (Gogu, 2021).

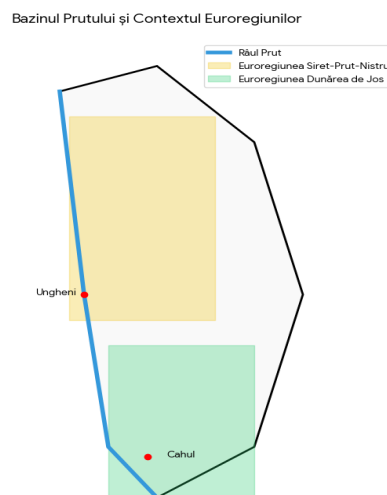


Figure 4. Spatial location of the Prut basin in the context of cross-border cooperation structures

Source: Developed by the author based on data from the "Siret-Prut-Nistru" Euroregion (2023).

The map presented in Figure 4 highlights the dual membership of the area to distinct Euroregional structures. The North and Center Sector (with the Ungheni pole) is integrated into the Siret-Prut-Nistru Euroregion, being influenced by the Iași economic pole. The South Sector (centered on the municipality of Cahul) belongs to the Lower Danube Euroregion, with a strategic opening towards the Galați-Brăila-Tulcea nodes. From a geographical perspective, this positioning should retain the population through mobility projects. However, the data show that, despite these frameworks, migration flows to the west remain dominant, transforming the basin into an area of demographic vacuum. Cross-border cooperation must move from the declarative level to common infrastructure projects (aqueducts, industrial parks) capable of stabilizing the age structure.

Gender structure: Feminization of aging and territorial imbalances

Between 2014 and 2024, the male-female ratio in the Prut basin underwent significant changes, influenced by selective migration and gender-differentiated mortality. This context outlines a profound demographic paradox: migration flows have transformed the region from a strategic area into a transit space marked by the transition to permanent family emigration. The phenomenon

generates a chronic negative migration balance and a pronounced feminization of rural aging, leaving communities dependent on deficient social services.

Structural mutations are manifested by two major imbalances:

Deficit of men at advanced ages: In the over-65 group, the ratio is distorted (60% women and 40% men) due to premature male excess mortality. The phenomenon leaves a population in the riverside villages predominantly made up of single elderly women, with high vulnerability (Penina, 2020).

The imbalance in the working age between urban and rural areas: While in villages women predominate, taking care of fragmented households, in the Ungheni and Cahul poles the share of active men is higher. This urban retention is favored by the concentration of jobs in industry, logistics and transport, sectors stimulated by the Free Economic Zones and the infrastructure of the Giurgiulesti Port (Ministry of Infrastructure and Regional Development of the Republic of Moldova, 2022).

Table 4. Population structure by sex and annual migration dynamics in the 12 districts of the Prut basin

District / Region	Female population (%)	Male population (%)	Migratory Balance (Est. annual average)	Structural profile and migration behavior
1. Briceni (Nord)	52,8%	47,2%	Negative (-1,8%)	Severe exodus of young people; rapid aging of the remaining population.
2. Ocnița (Nord)	53,1%	46,9%	Negative (-2,0%)	Advanced depopulation; high dependence on remittances.
3. Edineț (Nord)	52,5%	47,5%	Negative (-1,6%)	Permanent emigration of young families; negative natural increase.
4. Rîșcani (Nord)	52,4%	47,6%	Negative (-1,5%)	Constant losses in villages near the hydrographic node.
5. Glodeni (Centru)	52,6%	47,4%	Negative (-1,7%)	Structural decline; aging workforce in the agricultural sector.
6. Făleşti (Centru)	52,3%	47,7%	Negative (-1,6%)	Acute deficit of active human capital; exodus to the EU and Romania.
7. Ungheni (Centru)	51,5%	48,5%	Negative (-1,2%)	The most stable district; the municipality partially retains the male population.
8. Nisporeni (Centru)	51,8%	48,2%	Negative (-1,4%)	Intense pendular migration to the industrial pole Ungheni.
9. Hîncești (Sud)	51,9%	48,1%	Negative (-1,5%)	Constant migratory pressure to the capital and foreign destinations.
10. Leova (Sud)	52,1%	47,9%	Negative (-1,7%)	Demographic aging; contracting of local public services.
11. Cantemir (Sud)	52,3%	47,7%	Negative (-1,9%)	Critical demographic decline; rural localities exposed to desertification.
12. Cahul (Sud)	52,0%	48,0%	Negative (-1,5%)	Strong regional pole; attracts labor force but loses qualified young people.
Rural Average per Basin	53,2%	46,8%	Negative (-2,1%)	Major imbalance; human desertification in the meadow.

Source: Data estimated by the author based on the correlation of indicators of usual residence and demographic structure, National Bureau of Statistics of the Republic of Moldova (2024)

The demographic paradox of the Prut basin is that, although it is a strategic area of cross-border cooperation, migration flows have transformed the region into a transit space marked by the transition from individual to definitive family emigration; this phenomenon generates a chronic negative migration balance and a pronounced feminization of rural aging (60/40 ratio at ages over 65), leaving

communities vulnerable, lacking an active workforce and dependent on deficient social services that undermine any attempt at sustainable revitalization.

Identified problems and structural risks (challenges)

The severe demographic decline in the rural area of the Prut basin, which exceeds the threshold of 30%, generates a multidimensional domino effect with systemic impact on the cross-border region (Muntele, Grozavu and Roșu, 2018).

The major structural implications of this decline include:

Human desertification: Small villages in Cahul and Cantemir districts risk physical disappearance due to contractions of over 32% (BNS, 2025). Ocnița, Briceni and Leova districts have become areas of acute vulnerability, recording the largest declines in the country, of over 28%.

Degradation of human capital: The numerical contraction in Cahul district (BNS, 2024) represents a massive loss of active population. The phenomenon induces a chronic dependence on remittances to the detriment of local production (Gogu, 2021), while the urban poles of Ungheni and Cahul constantly lose qualified young people through brain drain (Chirică and Bejan, 2009).

Collapse of social infrastructure: The decrease in population has imposed the optimization of the school network by closing institutions in riverside villages (Ministry of Infrastructure and Regional Development of the Republic of Moldova, 2022). The high cost of maintenance per capita generates a vicious circle: the lack of educational services forces the permanent exile of young families.

Compromise of public utilities: New water and sewage systems risk economic inoperability due to the shortage of active beneficiaries (Interreg Next Romania-Republic of Moldova Cross-Border Program, 2024). Technically undersized consumption causes water stagnation in pipes, the appearance of biofilms and the deterioration of drinking water quality (Bacal and Burduja, 2018).

Agricultural and food crisis: The aging of the rural population, where the average age exceeds 40 years (Penina, 2020), blocks the digitalization and expansion of modern irrigation systems. The lack of skilled labor keeps agriculture at a rudimentary primary subsistence level.

Social pressure and polarization: There is a forced urbanization towards the centers of Edineț, Ungheni and Cahul (Table 2), transforming villages into satellite localities dominated by the elderly (Benedek, 2004). Family fragmentation through migration isolates the elderly and minors, overloading the social assistance of depopulated rural municipalities.

Opportunities, challenges and cross-border cooperation

Structural challenges and systemic demographic risks

The negative demographic transition in the Prut river basin generates cascading dysfunctions on the settlement network and the regional economy:

Systemic vulnerability: Ocnița, Briceni and Leova districts constitute critical areas, recording the most severe population contractions at the national level, of over 28%.

Decline of public services: The reduction of the school quota requires the closure or optimization of educational institutions, determining the permanent exodus of young families from rural areas (Ministry of Infrastructure and Regional Development of the Republic of Moldova, 2022).

Impact on the agricultural sector: The chronic labor shortage in agriculture directly compromises investments in modern irrigation systems and processing units (Bacal and Burduja, 2018).

Acute social pressure: The phenomenon of children left without parental care and the isolation of the elderly overstrains the budgets and operational capacity of social assistance services (Benedek, 2004).

Strategic levers and mechanisms of bilateral cooperation

The structural crisis can be mitigated by transforming demographic challenges into levers of sustainable development. Maximizing absorption through the Interreg Next Romania-Republic of Moldova programs allows for the co-financing of utilities and the digitalization of services for senescent communities. In parallel, the interconnection of cross-border aqueducts (Iași-Ungheni-Făleşti axis) stabilizes the viability of critical infrastructure, ensuring quality drinking water for the

remaining population (Government of the Republic of Moldova, 2021). The growth poles Ungheni and Cahul support regional resilience: Ungheni through its proximity to Romania and the performance of the Free Economic Zone, and Cahul through its university and tourist status (Ministry of Infrastructure, 2022). These poles constitute anchors capable of stopping the exodus of young people through digitalization, jobs and diversification of non-agricultural functions in small towns (Iargara, Costești).

Economic revitalization depends on the integration of infrastructure in the "Siret-Prut-Nistru" and "Lower Danube" Euroregions. New bridges and modernization of customs will transform the basin from a periphery into an active logistics corridor, facilitating daily commuting to the detriment of permanent migration. This framework allows access to funds for smart water management systems (Smart Water Management) and ecological tourism in the "Lower Prut" Biosphere Reserve (Academy of Sciences of Moldova, 2020). By automating meadow agriculture with technologies independent of the volume of the workforce, the region ensures its food security, offering young people economic arguments to project their future in the Prut basin.

Conclusions

The analysis of demographic dynamics in the Prut basin (2014–2024) highlights a systemic vulnerability defined by pronounced rural depopulation, structural regression and critical pressure on public investments (Muntele, Grozavu and Roșu, 2018). The population decrease by over 25–30% in the riverside villages (Cahul, Ungheni, Briceni), confirmed by the usual residence indicator, reveals an acute structural crisis masked by scriptural data (BNS, 2025). This decline has generated a severe generational imbalance (average age >40 years, ratio of 1.5 elderly/child), amplifying the gap compared to the resilience of the urban poles of Ungheni and Cahul. This aging directly endangers the sustainability of critical infrastructure (Penina, 2020), with the shortage of young specialists jeopardizing the maintenance of water systems (Bacal and Burduja, 2018).

In the "Lower Danube" Euroregion, a major discrepancy appears between investments and beneficiaries (Ministry of Infrastructure, 2022); the new highways risk serving an aging population, with minimal consumption and low payment capacity, altering the technical and economic depreciation indicators. In order to optimize the settlement network, the transition to territorial efficiency and non-agricultural diversification in small towns such as Iargara or Costești is imperative (Benedek, 2004). Recovery depends on the partnerships of the "Siret-Prut-Nistru" Euroregion with the counties of Iași and Vaslui for technological transfer in water management (Euroregion "Siret-Prut-Nistru", 2023). The "urn" demographic structure requires automated systems (Smart Water Management) to compensate for the lack of active labor force (Interreg Next Cross-Border Program, 2024). Integration through new infrastructure and eco-tourism in the "Lower Prut" Biosphere Reserve can transform this periphery into a dynamic economic corridor, avoiding demographic collapse (Academy of Sciences of Moldova, 2020).

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IDENTITY AND SOCIO-CULTURAL RECONFIGURATION OF THE PERI-URBAN SPACE OF CHIȘINĂU MUNICIPALITY

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Abstract: *The peri-urban space of Chișinău municipality is undergoing a continuous process of transformation under the influence of urbanization, suburbanization and the functional expansion of the capital city. The intensification of population mobility, residential development and the diversification of economic activities determine significant changes in the socio-cultural and identity structure of peri-urban localities. In this context, the peri-urban becomes a space of interference between traditional rural values and contemporary urban models, generating new forms of territorial organization, social interaction and identity expression. The aim of the study is to analyze the processes of identity and socio-cultural reconfiguration of the peri-urban space of Chișinău municipality in the context of sustainable development. The research seeks to identify the main factors influencing the identity, social and cultural transformations of peri-urban localities. The role of commuting, population mobility, human contacts and socio-cultural infrastructure used jointly in transforming the peri-urban environment and consolidating a new territorial identity is highlighted. The influence of urban-rural interactions on lifestyle, social behavior and the perception of inhabited space is also analyzed. The research findings reveal that the peri-urban space of Chișinău municipality acquires the characteristics of a transitional territory located at the intersection between tradition and modernity, rurality and urbanity. The identity and socio-cultural reconfiguration of this space represents both a consequence of current socio-economic transformations and an important premise for sustainable development and peri-urban territorial competitiveness.*

Keywords: *peri-urban space, territorial identity, sustainable development, suburbanization, Chișinău municipality, socio-cultural transformations, socio-spatial reconfiguration.*

JEL: R11, R23, R58, Z13

Introduction

The peri-urban space of Chișinău municipality represents one of the most dynamic areas of territorial transformation in the Republic of Moldova. It cannot be understood merely as an urban periphery or as a physical extension of the capital city. It must be analyzed as a space of interference between urban and rural, between tradition and modernity, between local belonging and functional integration into the peri-urban area of Chișinău municipality. In this territory, not only land use or the structure of housing changes, but also lifestyle, social relations, cultural practices and the collective representations of residents.

The relevance of the topic is determined by the dominant role of Chișinău municipality in the national settlement system. The capital city concentrates administrative, economic, educational, cultural and symbolic functions. It attracts population, investment, services and infrastructure. At the same time, this concentration generates pressure on nearby localities. Peri-urban localities become spaces of residence, daily mobility, consumption, recreation and real estate investment. They preserve rural elements, but are increasingly connected to urban rhythms. In this sense, the peri-urban space of Chișinău becomes a transitional territory in which local identity is continuously reconstructed.

The motivation for choosing this topic stems from the need to understand the social and cultural dimension of peri-urban transformations. A significant part of research on the peri-urban focuses on urban expansion, mobility, land, infrastructure or planning. These aspects are necessary, but not sufficient. Peri-urban reconfiguration is also an identity process. Long-term residents and newcomers do not use space in the same way. They may have different practices, different expectations and different representations of community. Therefore, the analysis of peri-urban space must include ways of life, local memory, socialization, territorial symbols and forms of community participation.

International studies show that peri-urbanization is a complex process generated by the expansion of urban activities beyond the administrative boundaries of the city. Woltjer (2014) defines peri-urbanization as the transformation of rural areas at the edge of cities into spaces with an increasingly urban character from a physical, economic and social point of view. The same author proposes three important dimensions: peri-urban space, peri-urban life and peri-urban change. This approach is also applicable to Chişinău, because it allows the peri-urban to be analyzed not only as a spatial form, but also as a way of life and as a social process.

In sociological literature, the peri-urban is considered a relatively recent but highly important object of research. Damon, Marchal and Stébé (2016) show that these spaces were long analyzed through the simple city-village opposition, although their reality is more complex. In the Eastern European and post-socialist context, Gnatiuk, Mezentsev and Provotar (2021) demonstrate that suburban and peri-urban spaces combine urban, rural and suburban practices. They are not simple territorial containers, but living environments that influence residents' behaviors and perceptions.

For the case of Chişinău, Nina Ivanova's research is particularly relevant. The author shows that the image of Chişinău in residents' representations includes a significant rural component. The urban-rural opposition does not appear as a rigid separation, but as a continuum of forms, practices and perceptions. This situation is explained by the particularities of urbanization in the Republic of Moldova, by the social stratification that followed the dissolution of the USSR and by intense internal migration (Ivanova, 2020).

The aim of the study is to analyze the processes of identity and socio-cultural reconfiguration of the peri-urban space of Chişinău municipality in the context of the interaction between urbanization, mobility, way of life and community transformations. The research objectives are: 1. to analyze the conceptual framework concerning the relationship between peri-urbanization, territorial identity and way of life; 2. to highlight the factors influencing the socio-cultural reconfiguration of Chişinău's peri-urban space; 3. to examine the relationship between rural belonging, urban functionality and the formation of a transitional peri-urban identity; 4. to formulate conclusions regarding the relevance of peri-urban research for sustainable development and the development of territorial public policies.

Methodologically, the article has a theoretical-analytical and synthetic character. The research is based on the analysis of specialized scientific sources, with emphasis on the literature concerning peri-urbanization, post-socialist urbanization, ways of life, urban identity and the demographic profile of Chişinău municipality. The methods used include documentary analysis, conceptual synthesis, comparison and socio-geographical interpretation. The methodological approach makes it possible to highlight the functional and identity transformations of the peri-urban space in the context of the expanding urban influence on adjacent localities. At the same time, the research contributes to understanding the socio-territorial dynamics specific to contemporary processes of peri-urban development.

The peri-urban space as a territory of socio-cultural transition

The peri-urban space is formed where the city extends its influence over nearby localities, while the rural gradually modifies its functional structure. This transformation does not mean the disappearance of the rural. Rather, it produces a combination of ways of life. In the peri-urban space, traditional households, modern individual housing, new residential functions, diversified economic activities

and daily mobility towards the city intersect. Therefore, the peri-urban cannot be described solely through administrative criteria. It must be understood as a relational space.

Woltjer (2014) explains peri-urbanization through three dimensions: spatial manifestations, activities and uses, and flows and factors of change. The first dimension refers to the expansion of the city and the mixture between urbanized land and land with rural functions. The second refers to the emergence of mixed economic, residential and social activities. The third concerns population mobility, investment, pressure on land and institutional changes. This scheme is useful for the analysis of Chişinău, because peri-urban localities are simultaneously influenced by housing, migration, infrastructure, consumption and social relations.

In the case of Chişinău municipality, this hybridization is amplified by its role as capital city and as the main concentration of resources, services and opportunities. Peri-urban localities become increasingly attractive through the possibility of individual housing, access to land, proximity to nature and the preservation of local community ties. Thus, an intermediate form of habitation emerges, situated between rural and urban. Residents may have their domicile in a locality with a rural appearance and traditions, while carrying out their professional activity, studies, consumption and social relations in the city. This situation contributes to the formation of a transitional identity specific to peri-urban space.

Sochircă (2010) shows that Chişinău municipality has experienced a territorial and demographic evolution strongly influenced by historical, social and economic factors. The capital city has expanded its functions and extended its area of influence over the adjacent space. This perspective is important for the analysis of the peri-urban. It shows that the relationship between the city and nearby localities is not recent, but in the contemporary period it becomes more intense and more diversified. Chişinău influences not only the economy of nearby localities. It also influences aspirations, behaviors, representations and lifestyles.

This reconfiguration is also specific to other post-socialist spaces. Gnatiuk, Mezentsev and Provotar (2021) show that suburbanization in post-socialist spaces does not fully reproduce the Western model and includes different scenarios determined by residents' social profile, their origin, the motivations for relocation and their relationship with the city. In the peri-urban space, long-term residents, young families, middle-income people, commuters, internal migrants and people who use the locality as a transitional space may coexist. This diversity generates different everyday practices.

For Chişinău, this is essential. The peri-urban space is not homogeneous. Some localities are more strongly integrated into urban flows. Others preserve rural structures more visibly. Some become attractive for individual housing. Others face insufficient infrastructure and pressure on services. In all cases, however, local identity is reconstructed. It is no longer exclusively rural, but neither is it entirely urban. Identity becomes peri-urban.

This identity can be observed in the changing relationship between private space and public space. In peri-urban localities, the household remains important. The house, the courtyard and the land have social and symbolic value. At the same time, the importance of access to roads, transport, schools, medical services, internet, commercial and cultural spaces increases. Residents no longer evaluate the locality only through tradition and neighborhood relations. They also evaluate it through connectivity, comfort, accessibility and environmental quality.

Therefore, the identity reconfiguration of the peri-urban is a process of negotiation. Residents negotiate between rural memory and urban aspiration. They negotiate between belonging to the community and daily mobility towards the city. They negotiate between traditions and modern practices. This negotiation should not be interpreted as an identity crisis. It may be understood as a form of adaptation to contemporary territorial changes.

Way of life, mobility and the transformation of everyday practices

Way of life is an important conceptual key for understanding socio-cultural reconfiguration. Hachi (2005) defines way of life as a generalizing characteristic of the life of the population of a territory.

It includes activities, material and spiritual choices, behaviors, values and stereotypes. The author emphasizes that way of life expresses the socio-economic and socio-cultural identity of a social group with a concrete spatiality. This approach allows the peri-urban to be analyzed not only through infrastructure, but through the actual life of the population.

In the peri-urban space of Chişinău, way of life and consumption are closely connected to the city. The locality of residence becomes a space of living, but the city remains the main source of opportunities. This functional dependence changes the rhythm of life. The social time of residents is organized around travel, working schedules and access to urban services.

The demographic profile of Chişinău municipality shows that the municipality attracts population from other localities of the country. A considerable share of respondents report having changed their domicile in recent years, and young people are the most mobile category (Rusu, 2022). This confirms the role of Chişinău as a pole of attraction. At the same time, it shows that urban and peri-urban identity is influenced by internal migration. Residents arriving from other localities bring different practices, norms and experiences. They participate in the formation of a mixed urban and peri-urban culture.

This mobility produces effects on peri-urban communities. Long-term residents may preserve traditional forms of solidarity. New residents may have expectations oriented towards comfort, services and rapid access to the city. Differences between these groups may lead to tensions, but also to social innovation. The peri-urban community becomes more diverse. Neighborhood relations change. Participation in local life may become weaker if the locality is perceived only as a dormitory space. However, it may become stronger if residents develop joint projects and attachment to place. Ivanova (2020) observes that the image of Chişinău is marked by the coexistence of the urban and the rural. The author proposes the interpretation of the existence of two symbolic entities: one urban and one rural, which structure the perception of space and reflect the functional and identity duality of the city. This idea can also be extended to the peri-urban. Peri-urban localities have their own symbolic centers: the church, the school, the household, the main street and the memory of local families. At the same time, they are oriented towards the urban center of Chişinău. Thus, residents live between two systems of reference.

The transformation of everyday practices can also be observed in the relationship between generations. Young people are more connected to the city, education, mobility and digital communication. Older people preserve more strongly the memory of place and traditional forms of socialization. Young families may choose peri-urban localities for residence, but they depend on the city for work, kindergartens, schools, medical services and cultural activities. Thus, the peri-urban becomes a space of generational differences.

Hachi (2005) shows that way of life is influenced by mentality, traditions, socio-cultural stereotypes, population mobility and the settlement system. In the peri-urban space of Chişinău, these factors act simultaneously. Local tradition does not disappear, but is reinterpreted. The rural household may coexist with an urban style of consumption. Family networks may coexist with more individualized social relations. Neighborhood practices may coexist with the anonymity specific to urban life.

This combination has effects on identity. Peri-urban identity is not a simple sum of rural and urban elements. It is the result of the interaction between them. Residents may preserve attachment to the village or suburb, while adopting urban norms of consumption, education and mobility. They may value quietness, green space and their own household, while demanding infrastructure and services of urban quality. This dual orientation defines the socio-cultural specificity of the peri-urban.

Territorial identity between rural belonging and urban functionality

Territorial identity is formed through the relationship between place, memory, social practices and collective representations. In the peri-urban space of Chişinău municipality, this identity is influenced by proximity to the capital city. Peri-urban localities cannot be analyzed only as administrative units.

They must be understood as spaces in which residents permanently negotiate belonging to the local community and integration into the urban system.

Rural belonging is expressed through the memory of place, family networks, traditions, local holidays, household practices and neighborhood relations. Urban functionality is manifested through dependence on jobs, education, medical services, trade, culture and administration in the city. The peri-urban resident may be, simultaneously, a member of a local community and a daily user of the city of Chişinău. His or her identity is not contradictory, but layered, resulting from the overlap and integration of different social and spatial practices.

This complex identity is important for territorial policies. If peri-urban localities are treated only as spaces of residential expansion, their social dimension is lost. If they are treated only as traditional villages, their real integration into the urban system is ignored. An effective policy must recognize the dual character of these territories. They need urban infrastructure, but also the protection of local community and cultural resources.

Petre (2008) demonstrates that residential peri-urbanization in Romania has generated a new peri-urban model in which the urban population settles in rural localities close to the city. The author emphasizes the emergence of new social relations between the local population and newcomers. This model is also relevant for Chişinău, even though it has local particularities. In both cases, peri-urban localities become spaces of encounter between old and new, between rural and urban, between traditional property and new forms of housing.

At the same time, the peri-urban should not be idealized. Identity reconfiguration may also produce social fragility. Residential growth may exceed the capacity of infrastructure. Daily mobility may reduce the time available for community participation. New residents may have a weaker relationship with local memory. Long-term residents may perceive changes as a loss of local specificity. These tensions are natural in a space undergoing transformation, but they must be managed through dialogue and planning.

Landry and Bianchini (1995) emphasize the role of creativity in the development of cities. Cities are spaces of interaction, diversity and innovation. This idea can also be applied to the peri-urban. Peri-urban localities can become spaces of local creativity, not merely residential zones. They can develop cultural activities, community initiatives, recreational spaces, local services and heritage projects. Thus, peri-urban identity can become a resource for development.

For Chişinău municipality, this direction is important. The capital city has high cultural and educational potential. Peri-urban localities can benefit from this proximity, but they must also preserve their own specificity. Identity reconfiguration should not lead to uniformity. On the contrary, it can create a network of localities with distinct profiles, connected to the city, but capable of offering quality of life and local belonging.

Peri-urban identity can be consolidated through public spaces, local events, community education, heritage protection, civic participation and intercommunity cooperation. It can be expressed through local names, traditions, landscapes and cultural practices, but also through new forms of urban expression. What is important is that residents should not be mere consumers of space, but participants in its social production.

Implications for sustainable development and territorial public policies

The identity and socio-cultural reconfiguration of the peri-urban has direct implications for sustainable development. Public policies cannot approach the peri-urban only through construction regulations or infrastructure expansion. They must take into account way of life, social cohesion, mobility, access to services, environmental quality and local identity.

Woltjer (2014) shows that institutional responses to peri-urbanization are often insufficient because they fail to capture the dynamic and fragmented character of these territories. This observation is also relevant for Chişinău. Peri-urban localities are influenced by flows that exceed local administrative

competences. Migration, real estate investment, daily mobility and pressure on land require metropolitan coordination.

The sustainable development of the peri-urban must start from the recognition of the interdependence between the city and nearby localities. Chişinău offers jobs, education, services and culture. Peri-urban localities offer residential spaces, land resources, natural environment and community potential. This interdependence must be managed through integrated planning.

The demographic profile of Chişinău municipality shows the need for people-centered policies adapted to demographic changes (Rusu, 2022). This recommendation may be extended to the peri-urban. Policies must take into account young people, families, older persons, commuters, internal migrants and vulnerable groups. Each category has different needs. Young people need education, mobility and opportunities. Families need care services, housing and infrastructure. Older persons need access to services and the preservation of social networks.

At the same time, policies must protect the cultural dimension of peri-urban localities. Residential development should not destroy the memory of place. New neighborhoods must be integrated into the community. Public spaces should encourage interaction. Infrastructure should connect rather than fragment. Planning must include consultation with residents, because territorial identity cannot be created exclusively through administrative decisions.

Thus, the peri-urban space of Chişinău must be treated as a strategic space. It is important for the balanced development of the capital city, for quality of life, for reducing pressure on the urban center and for consolidating a modern territorial identity that remains anchored in local specificity.

Conclusions

The identity and socio-cultural reconfiguration of the peri-urban space of Chişinău municipality is a complex process determined by urbanization, mobility, internal migration, changes in way of life and the extension of the capital city's functions over nearby localities. The peri-urban cannot be reduced to the status of a city margin. It represents a space of transition, interaction and hybridization, in which rural and urban forms coexist and transform each other.

The analysis of the sources demonstrates that peri-urbanization produces not only spatial changes, but also profound social transformations. Woltjer (2014) proposes understanding the peri-urban through the relationship between space, life and change. This approach is relevant for Chişinău, because peri-urban localities are simultaneously influenced by urban expansion, population mobility, the transformation of activities and pressure on infrastructure. Damon, Marchal and Stébé (2016) draw attention to the fact that the peri-urban was for a long time difficult to place within the traditional categories of urban sociology. This difficulty is also found in the case of Chişinău, where the simple urban-rural opposition is no longer sufficient.

In the case of Chişinău municipality, identity reconfiguration is closely linked to the role of the capital city as a pole of attraction. Chişinău concentrates opportunities and generates internal population flows. These flows modify the structure of communities and everyday practices. The demographic profile of the municipality confirms the importance of internal mobility and of the attraction exerted on young people and the working-age population (Rusu, 2022). This dynamic directly influences peri-urban localities. They become residential spaces for people with different social experiences and different expectations towards community.

An important conclusion is that peri-urban identity has a layered character. It combines rural belonging with urban functionality. Peri-urban residents may preserve links with tradition, family, household and local memory. At the same time, they depend on the city for work, education, services and consumption. This dual belonging should not be interpreted as a contradiction. It represents the specific form of adaptation of communities to contemporary territorial transformations.

Way of life is a central element of this reconfiguration. Hachi (2005) shows that way of life expresses the activities, choices, values and behaviors of the population of a territory. Applied to the peri-urban

space of Chişinău, this perspective allows transformations to be understood beyond physical indicators. It shows that peri-urban development must be analyzed through residents' everyday life, through their social relations, mobility, consumption, participation and representations of place.

Socio-cultural reconfiguration may have positive effects. It may stimulate the modernization of localities, the diversification of activities, the emergence of new services and the consolidation of a more open territorial identity. However, it may also generate risks. These include social fragmentation, the weakening of community cohesion, pressure on infrastructure, the loss of local specificity and the transformation of peri-urban localities into residential spaces without community life. Therefore, peri-urban development must be managed through integrated policies.

For public policies, the main implication is the need for a metropolitan and socio-cultural approach to the peri-urban. Infrastructure expansion is not sufficient. It is necessary to strengthen public spaces, protect local heritage, stimulate civic participation, develop social and cultural services and integrate new residents into community life. The peri-urban must be viewed as a resource for sustainable development, not merely as a land reserve for the expansion of the city. Public policy formulations can be more precisely grounded following in-depth sociological research proposed within the doctoral study.

Finally, the peri-urban space of Chişinău municipality may be defined as a laboratory of social and territorial change. Here, the transformation of the relationship between urban and rural can be observed most clearly. Here, new practices of habitation, new lifestyles and new forms of belonging are formed. Researching this space is important for understanding the future of Chişinău municipality and for grounding public policies that are more balanced, more sensitive to local identity and more oriented towards quality of life.

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DETERMINING THE COMPETITIVE ADVANTAGES OF TECHNICAL-MUNICIPAL INFRASTRUCTURE AND PUBLIC SERVICES IN THE CITIES OF THE NORTHERN DEVELOPMENT REGION OF THE REPUBLIC OF MOLDOVA.

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Abstract: *This article evaluates the competitive advantages of technical-municipal infrastructure and public services in the cities of the Northern Development Region of the Republic of Moldova. The research utilizes data from the 2024 Census, focusing on the accessibility of utility networks, street infrastructure, and green spaces. The methodology applies statistical distance analysis (Euclidean, Manhattan, Gower, Chord, and Mahalanobis) to determine the degree of proximity to the municipality of Bălţi. The results, processed in JASP, highlight major territorial disparities, ranking the localities according to their level of infrastructural equipment. Gower indicators confirm a high convergence for the cities of Drochia and Otaci, while Lipcani and Mărculeşti show significant structural gaps. The study demonstrates the efficiency of statistical methods in evaluating urban competitiveness and providing a foundation for regional cohesion policies.*

Keywords: *technical-municipal infrastructure, public services, Northern Development Region, statistical distances, urban competitiveness, regional cohesion .*

JEL: R11, R58, H54.

Introduction

In the specialized literature, urban infrastructure is approached as a complex system of interconnected networks and services that support the functionality and development of cities [4]. Within this system, technical-municipal infrastructure and public services represent essential elements that sustain urban functionality, economic development, and the population's quality of life [3]. In the context of contemporary regional development strategies, urban infrastructure is no longer perceived exclusively as the physical support of the city, but as a strategic factor that contributes to increasing investment attractiveness and strengthening territorial competitiveness. The development level of technical-municipal networks and public services reflects the degree of urban modernization and the capacity of local administrations to respond to the needs of the population and the economic environment. Access to water supply infrastructure, sewerage, natural gas, public lighting, street infrastructure, and green spaces directly influences housing conditions, urban mobility, and the socio-economic development potential of cities.

In the Northern Development Region of the Republic of Moldova, the existing differences between cities regarding the level of municipal equipment generate significant territorial disparities and influence their capacity to capitalize on development opportunities. In this context, evaluating the

competitive advantages of technical-municipal infrastructure and public services becomes necessary for identifying structural imbalances and providing a foundation for regional development policies. The present research aims to conduct a comparative analysis of the cities in the Northern Development Region by assessing the level of infrastructural development and identifying urban competitive advantages based on relevant statistical indicators.

Materials and Research Methods

The research is based on a multivariate quantitative analysis of technical-municipal infrastructure, defined as a set of interconnected structures and services necessary for the functioning of the urban environment. To evaluate competitive advantages, five key indicators were selected: green spaces (m²/inhabitant), street density (km/km²), public lighting rate (%), connection to the sewerage service (%), and access to network natural gas (%) [1,2]. Since these indicators have heterogeneous units of measurement, the values were standardized using the range normalization method (Min-Max scaling), thus ensuring the full comparability of the data. The assessment of the development level was performed by calculating the degree of proximity to the polarizing center (the municipality of Bălți), employing a complementary set of statistical metrics: Euclidean, Manhattan, Gower, Chord, and Mahalanobis distances. This approach allows for the triangulation of results and the elimination of interpretation biases inherent to a single calculation method. The data were processed in the JASP statistical environment, generating a distance matrix that underpins the identification of competitiveness clusters and areas requiring strategic interventions to mitigate territorial imbalances.

The infrastructural profile of the cities within the Northern Development Region exhibits a high degree of heterogeneity. The data presented in Table 1 highlight major territorial disparities among the analyzed urban centers. The municipality of Bălți, serving as the benchmark unit, records maximum values across most indicators, particularly regarding sewerage connection rates (98.1%) and public lighting.

Table 1. Infrastructural indicators of urban settlements in the Northern Development Region

Urban Settlements	Green spaces (m ² /inhab.)	Street density (km/km ²)	Illuminated streets (%)	Dwellings connected the public sewerage service (%)	Housing equipped with network gas (%)
mun. Bălți	35,8	10,1	93,6	98,1	71
Briceni town	77,2	8,2	100,0	71,2	53,1
Lipcani town	91,2	5,2	100,0	48	14,1
Dondușeni town	33,9	9,5	79,5	71,6	86,5
Drochia town	79,0	11,4	90,2	82,5	70,9
Edineț town	38,7	7,7	43,0	63,5	67,7
Cupcini town	57,2	4,7	57,7	67,7	48,9
Fălești town	25,9	14,3	95,9	68,6	24,5
Florești town	118,4	14,3	62,2	76,7	59,3
Ghindești town	23,4	19,5	95,1	65,6	59,3
Mărculești town	116,5	14,1	100,0	41,4	35,5
Glodeni town	93,7	8,0	29,8	62,4	75,5
Ocnîța town	31,2	15,7	74,3	79,5	66,4
Frunză town	8,5	14,8	36,4	99,4	87,9
Otaci town	17,0	10,6	83,2	95,7	44,7
Rîșcani town	24,5	9,0	53,9	73,6	65,6
Costești town	41,6	2,5	96,7	46,1	13,5
Sîngerei town	38,3	10,1	80,2	52,2	39,3

Biruința town	34,5	13,8	97,5	72,8	49,6
Soroca town	32,9	12,6	69,5	76,8	37,4

Source: elaborated by the authors based on source [1,2].

The comparative analysis indicates significant differences between cities of similar rank. Towns such as Drochia and Florești exceed the regional average in terms of municipal utilities and green spaces. In contrast, localities like Lipcani and Costești exhibit structural deficiencies in their gas and sewerage networks. This uneven distribution of infrastructure suggests fragmented competitive advantages, influenced by administrative status or proximity to transport axes.

To analyze these gaps, a matrix of normalized values was utilized (Table 2). The values, ranging from 0 to 1, allowed for the identification of each city's position relative to the maximum regional standard.

Table 2: Matrix of Normalized Values for Technical-Municipal Infrastructure Indicators in the cities of the Northern Development Region (2024)

Urban Settlements	Green spaces (m ² /inhab.)	Street density (km/km ²)	Illuminated streets (%)	Dwellings connected to the public sewerage service (%)	Housing equipped with network gas (%)
mun. Bălți	0,249	0,447	0,909	0,978	0,773
Briceni town	0,625	0,336	1,000	0,514	0,532
Lipcani town	0,753	0,157	1,000	0,114	0,008
Dondușeni town	0,231	0,412	0,708	0,521	0,981
Drochia city	0,641	0,523	0,860	0,709	0,772
Edineț town	0,275	0,308	0,188	0,381	0,728
Cupeini town	0,443	0,129	0,397	0,453	0,476
Fălești town	0,159	0,693	0,942	0,469	0,148
Florești town	1,000	0,692	0,461	0,609	0,616
Ghindești town	0,135	1,000	0,930	0,417	0,616
Mărculești town	0,982	0,684	1,000	0,000	0,296
Glodeni town	0,775	0,323	0,000	0,362	0,833
Ocnița town	0,207	0,776	0,633	0,657	0,711
Frunză town	0,000	0,722	0,093	1,000	1,000
Otaci town	0,077	0,478	0,761	0,936	0,419
Rîșcani town	0,146	0,381	0,343	0,555	0,700
Costești town	0,301	0,000	0,954	0,081	0,000
Sîngerei town	0,272	0,448	0,718	0,186	0,347
Biruința town	0,237	0,665	0,964	0,541	0,485
Soroca town	0,223	0,593	0,565	0,610	0,321

Source: Calculated by the authors using JASP software based on the data from Table 1.

This normalized database serves as the foundation for calculating statistical distances (Euclidean, Manhattan, Gower, Chord, and Mahalanobis), which reveal the actual degree of similarity or disparity between the urban infrastructure of localities in the Northern Development Region of the Republic of Moldova.

The multidimensional assessment of competitiveness was conducted by quantifying the degree of proximity of urban centers to the benchmark model, utilizing statistical distance metrics. The results presented in Table 3 provide a clearer insight into the competitive advantages of each locality through the lens of municipal infrastructure.

Table 3: Matrix of Statistical Distances of Urban Centers in the Northern Development Region Relative to the Benchmark Model

Urban Centers	Euclidean Distance	Manhattan Distance	Gower Distance	Chord distance	Mahalanobis distance
Briceni town	0,660	1,283	0,257	0,413	0,789
Lipcani town	1,295	2,514	0,503	0,867	1,576
Dondușeni town	0,542	0,919	0,184	0,327	1,322
Drochia town	0,484	0,787	0,157	0,300	0,732
Edineț town	0,948	1,528	0,306	0,529	1,696
Cupcini town	0,874	1,846	0,369	0,399	1,374
Fălești town	0,848	1,503	0,301	0,537	1,612
Florești town	0,993	1,970	0,394	0,622	1,764
Ghindești town	0,812	1,406	0,281	0,508	1,830
Mărculești town	1,336	2,516	0,503	0,832	1,986
Glodeni town	1,225	2,235	0,447	0,820	1,915
Ocnîța town	0,541	1,030	0,206	0,328	1,252
Frunză town	0,925	1,589	0,318	0,575	1,491
Otaci town	0,424	0,747	0,149	0,225	1,011
Rîșcani town	0,721	1,231	0,246	0,324	1,359
Costești town	1,268	2,214	0,443	0,865	1,720
Sîngerei town	0,920	1,433	0,287	0,515	1,662
Biruința town	0,570	1,010	0,202	0,347	1,087
Soroca town	0,693	1,336	0,267	0,333	1,554

Source: elaborated by the authors using JASP software.

The validity of this ranking is confirmed by the convergence of the metrics employed, each providing a specific perspective:

- Gower Distance – indicates a balanced distribution of performance. The low values for Otaci (0.149) and Drochia (0.157) suggest mature infrastructural systems;
- Euclidean and Manhattan Distances – highlight the magnitude of the gaps. In the case of Lipcani, the Manhattan value of 2.514 signals an accumulation of critical structural handicaps;
- Mahalanobis Distance – confirms the consistency of the municipal system. The values for Briceni (0.789) and Drochia (0.732) attest to a systemic evolution of the indicators;
- Chord Distance – reflects differing investment priorities. For instance, Biruința (0.347) and Ocnîța (0.328) present similar scores but possess distinct infrastructure supply structures.

Based on these data, the formation of three homogeneous groups is observed, which maintain their hierarchical positions regardless of the metric applied:

- ✓ High-Performance Group (Otaci, Drochia, Ocnîța, Biruința, and Briceni): These form the core of statistical stability, exhibiting the highest degree of similarity to the benchmark model.
- ✓ Medium-Performance Group (Dondușeni, Rîșcani, Soroca, and Sîngerei): This group reflects a consolidation stage, albeit with asymmetries that require targeted investments.
- ✓ Structural Disparity Group (Lipcani, Mărculești, Glodeni, and Costești): This cluster stands out due to maximum distance values, indicating chronic deficiencies across most of the analyzed indicators.

For an in-depth interpretation of proximity relationships, the distance matrix was graphically transposed into a hierarchical tree based on the Neighbor-Joining algorithm (Figure 1).

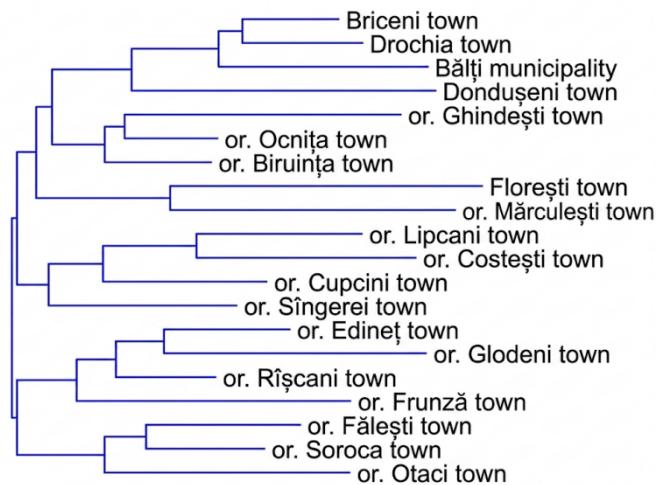


Figure 1. Hierarchical Tree of Infrastructural Proximity (Neighbor-Joining Algorithm based on Mahalanobis Distance).

Source: Elaborated by the authors using JASP software.

The use of Mahalanobis distance in this model is essential, as it eliminates informational redundancy by weighting the correlations between indicators, thus providing a faithful representation of structural similarity. The visual analysis of the hierarchical configuration reveals the following fundamental aspects:

- Validation of the Benchmark Core: A primary, extremely short branching is observed between the municipality of Bălți and the towns of Briceni and Drochia, confirming their convergence toward the maximum performance model.
- Structure of the Resilience Group: Cities such as Ocnița, Biruința, and Dondușeni are clustered on adjacent branches, demonstrating a synchronized trajectory of infrastructural development.
- Highlighting Territorial Anomalies: Localities positioned on the longest and most isolated branches (e.g., Lipcani, Costești) reflect not only a quantitative deficit but also a public service architecture that is profoundly divergent from regional standards.

Conclusions

1. Polarized Competitive Advantage: Competitive advantage in technical-municipal infrastructure within the Northern Development Region is highly polarized, with only a narrow core of cities (Otaci, Drochia, Briceni) significantly approaching the benchmark model represented by the municipality of Bălți.
2. Structural Convergence vs. Statistical Proximity: Statistical proximity to a reference center does not guarantee actual structural convergence; cities with similar distances may exhibit completely different infrastructure profiles, reflecting distinct investment trajectories.
3. Systemic Reinforcement of Deficits: Infrastructural deficits do not manifest in isolation but are systemically self-reinforcing—a city with poor sewerage connectivity typically exhibits reduced access to gas networks or green spaces, creating structural development traps.
4. Resilience and Quantitative Disparities: Quantitative differences in municipal provisions translate into qualitative differences in territorial resilience; cities with chronic disparities (Lipcani, Mărculești, Costești) are more vulnerable to demographic and economic shocks.
5. Strategic Diagnostic through Triangulation: The triangulation of statistical metrics (Euclidean, Manhattan, Gower, Chord, and Mahalanobis) transforms descriptive ranking into a strategic

diagnostic, allowing for the precise identification of gap types and providing the foundation for regional cohesion policies tailored to each city category.

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SECTION 8: LAW

EUROPEAN LEGISLATIVE MODELS ON THE CRIMINALIZATION OF LEAVING THE SCENE OF A ROAD ACCIDENT

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Abstract: *The experience of European countries in regulating the criminalization of various criminal acts has undoubtedly been a benchmark for developing countries, a fact that is also specific for the Republic of Moldova. Given that the crime of leaving the scene of a road accident is regulated by most European Union states, the present study will focus on the analysis of the rules that apply in this matter, drawing a parallel with those provided for in art. 266 of the Criminal Code of the Republic of Moldova. The planned study will also refer to some doctrinal opinions expressed by the European doctrine when examining the content of the rules in the field of criminalizing the act of leaving the scene of a road accident.*

The initial findings from the study of the national norm that sanctions leaving the scene of a road accident indicate some regulatory confusion, where the qualification of the act requires the necessary presence of guilt of the person who committed the road accident, which means that in the absence of guilt for the accident, the person who leaves the scene of the act does not fall under the scope of this norm, an unacceptable fact in the context in which the legislator requires remaining at the scene for reasons other than the guilt of the driver involved in the accident.

For greater efficiency in research, widely known methods are applied such as: the analysis method, the synthesis method, the comparative method and the deduction method.

Key words: *crime, road accident, driver, crime scene, guilt, criminal liability.*

JEL: K14, K42, K19

Introduction

The criminalization of the act of leaving the scene of a road accident has been known to the Moldovan legislative space since 2002, with the adoption of the new Criminal Code. Since then and until now, the text of the norm in art. 266 has not undergone essential changes, stating that "leaving the scene of a road accident by the person who was driving the means of transport and who violated the rules of traffic safety or operation of the means of transport, if this caused the consequences indicated in art. 264 para. (1), (3) and (5)" (Criminal Code of the Republic of Moldova).

However, the tactics of legislating on the matter of criminal liability for leaving the scene of a road accident still remain contested by the doctrine, the act is difficult to qualify by the criminal prosecution body, respectively, difficult to enforce by the courts.

Researchers have made constant efforts to convince our legislator to resort to a different approach to the problem of leaving the scene of a road accident, without taking into account the fact of violating road safety regulations or the consequences of the accident, in the context in which the essence of the criminalization must revolve around the idea of the obligation to remain at the scene to provide

assistance to the victim, to limit the consequences of the accident on the affected goods and environmental components, but also to make it possible to ascertain the circumstances of the act. Thus, all these ambiguities still give us reason today to continue research towards identifying the most optimal and efficient framework for incriminating the criminal act of leaving the scene of a road accident, without questioning the necessity of its criminal conviction.

Moreover, many other states that until recently ignored the need to criminalize leaving the scene of a road accident, between 1990-1999 opted to intensify research towards formulating a criminal norm in this regard. Moreover, the Constitutional Courts of some European states (France, Germany, Spain), but also of states outside the European area (Canada), after 1990 examined the opportunity to criminalize the act of leaving the scene of a road accident (STATI Vitalie, 2009).

Basic content

In the following, we will analyze the main features that characterize the criminal legislation of the European Union countries in the section that deals with the sanctioning of the act of the driver of the means of transport who left the scene of the road accident in which he was involved. The first country that draws our attention through its regulations is Romania, because it is our neighboring state from whose legislation we have been inspired on many occasions, but also whose regulatory traditions are specific to our country, especially in an integrationist context.

Thus, the Romanian criminal law criminalizes the act of leaving the scene of a road accident or modifying its traces based on art. 338 of the Criminal Code contained in Chapter II (Offenses against traffic on public roads).

Therefore, according to the rule under discussion:

- (1) Leaving the scene of the accident, without the consent of the police or the prosecutor conducting the investigation of the crime scene, by the driver of the vehicle or by the driving instructor, who is in the process of training, or by the examiner of the competent authority, who is in the process of conducting the practical tests of the exam for obtaining a driving license, involved in a traffic accident, is punishable by imprisonment from 2 to 7 years.
- (2) The same punishment is also imposed on any person who modifies the condition of the scene or erases the traces of the traffic accident that resulted in the killing or injury to the bodily integrity or health of one or more persons, without the consent of the investigation team on the scene.
- (3) It is not a crime to leave the scene of an accident when:
 - a) only material damage has occurred as a result of the accident;
 - b) the driver of the vehicle, in the absence of other means of transport, transports the injured persons himself to the nearest health unit capable of providing the necessary medical assistance and to which he has declared his personal identity data and the registration or registration number of the vehicle driven, recorded in a special register, if he immediately returns to the scene of the accident;
 - c) the driver of the vehicle with priority traffic immediately notifies the police, and after completing the mission he reports to the headquarters of the police unit in whose jurisdiction the accident occurred, in order to draw up the documents of assessment
 - d) the victim leaves the scene of the crime, and the driver of the vehicle immediately reports the event to the nearest police unit (Romanian Criminal Code).

As we can see, the Romanian legislator criminalizes the act of leaving the scene of a road accident through the norm that also deals with the criminalization of the act of modifying the terrain in which it occurred. Therefore, in this regulatory tactic, we identify the general idea that was the basis for the criminal punishment of the act of leaving the scene of a road accident, that is, to ensure the integrity of the traces necessary to accurately establish the circumstances in which the accident occurred. However, it is true that once the scene of a road accident is left, it becomes impossible to establish the real situation, both because one of the cars involved is missing, and for the situation in which,

even if the car remains at the scene, one of the drivers modifies the terrain left by the accident, the effect would be the same - the impossibility of establishing the truth.

Therefore, we consider the Romanian legislator's decision to also sanction the act of modifying the circumstances in which the road accident occurred to be quite inspired.

On the other hand, it is also worth noting that the same norm also specifies cases in which the driver of the means of transport leaves the scene of the accident, but these are not considered criminal acts (transporting the victim to the hospital, notifying the police, etc.).

Therefore, we note that Romanian legislation provides in the smallest details the situations that qualify as the crime of leaving the scene of a road accident, but also indicates all the exceptions.

Moreover, through a separate regulatory act (GEO no. 195/2002), it defines the road accident, but also establishes some obligations on the driver that he must fulfill immediately after the accident occurs.

Thus, according to art. 75 of Emergency Ordinance no. 195/2002, a traffic accident is considered an event that cumulatively meets the following conditions:

- a) it occurred on a road open to public traffic or originated in such a place;
- b) it resulted in the death, injury of one or more people or damage to at least one vehicle or other material damage;
- c) at least one moving vehicle was involved in the event.

Also, Article 77 of the same normative act provides that:

(1) The driver of a vehicle involved in a traffic accident resulting in the death or injury to the bodily integrity or health of a person is obliged to take measures to immediately notify the police, not to modify or erase the traces of the accident and not to leave the scene of the crime.

(2) Any person who is involved in or has knowledge of the occurrence of a traffic accident resulting in the death or injury to the physical integrity or health of one or more persons, as well as in the situation where a vehicle transporting dangerous goods is involved in the event, is obliged to immediately notify the police and call the single national emergency number 112.

(3) Any person is prohibited from changing the position of the vehicle involved in a traffic accident resulting in the death or injury to the physical integrity or health of one or more persons, from altering the condition of the scene or from erasing the traces of the accident without the approval of the police investigating the accident.

Returning to the analysis of the criminal norm criminalizing the act of leaving the scene of a road accident, we also note that the Romanian legislator does not link the composition of the crime to the driver's guilt for violating road traffic rules, the latter being punished regardless of whether he is guilty of ignoring traffic rules or not. We also agree with this position, because first of all, our criminal law does not provide for leaving a road accident as an aggravating factor for violating road traffic rules, but as a separate crime. Secondly, the criminalization of the act of leaving a road accident is based on another idea, namely that of remaining at the scene in order not to impede the administration of justice by distorting evidence (including evidence regarding the driver's state of intoxication), but also to provide the necessary assistance to the victim of the road accident, to limit its subsequent consequences on the injured means of transport (preventing it from setting fire, etc.) or on environmental components (by limiting fuel leakage into the soil, water, etc.).

The next European country to be presented as a model in the matter of criminalizing the act of leaving the scene of a road accident is France, which, in turn, is the country that has greatly inspired the Romanian legislator in several respects.

Therefore, the French Criminal Code regulates the criminalization of the act of leaving the scene of a road accident in the content of Book IV (On crimes and misdemeanors against the nation, the state and public peace), Title III, Section II (On obstacles to the administration of justice). What can be observed even from the tactics of structuring the Criminal Code in order to identify the place of this category of acts, is that leaving the scene of an accident constitutes a crime that attempts to administer

justice, since by committing it, real data about the accident is distorted, respectively, the procedure for documenting the act is thwarted.

Specifically, according to art. 434-10 of the French Criminal Code, the act of the driver of a means of land, river or sea transport or of another means or mechanism, of not stopping the movement and of attempting to evade criminal or civil liability, is punishable by two years' imprisonment or a fine of 200,000 francs.

If such an act is committed under the conditions provided for in art. 221-6 (negligent death) or 222-19 (total loss of work capacity), the punishment is doubled (ГОЛОБКО, L. V., КРЫЛОВОЙ, N. E., 2002).

Also, according to French law, the crime of leaving the scene of a road accident can be attributed to the perpetrator even if he compensated the damage caused to the victim of the crime or if the victim withdrew her complaint or the accident was insignificant and did not cause significant damage.

In a comparative perspective, different from our legislation, the French criminal law considers as a crime to leave the scene of a road accident and to continue driving after the impact, as well as the scene of the accident occurring at sea or rivers. Moreover, here too we identify the idea that leaving the scene of a road accident is strictly correlated with evading the criminal or civil liability of the perpetrator.

And yet, although most criminal laws condemn the act of leaving the scene of a road accident as an attack on the act of carrying out justice, some doctrinal opinions incline towards the incorrectness of this approach, claiming that by remaining at the scene, the driver of the means of transport risks testifying against himself, that is, incriminating himself, which is inadmissible in terms of human rights.

In this sense, the authors who support this position mention that "the privilege against self-incrimination is the principle according to which the state cannot force a suspect to cooperate with the prosecution by providing evidence that could incriminate him. That is, if the person remains at the scene and makes the independent decision to preserve the scene of the incident, he admits his guilt, somehow self-incriminating himself through the obligation imposed by law to identify himself" (ȚICAL, G. M., CHIRUȚA A., 2019). However, in arguing their position, the authors also argue that by establishing the obligation to remain at the scene, the perpetrator is forced to preserve evidence and contribute to his own incrimination, which contravenes art. 6 of the ECHR (the right to remain silent and not to attempt to contribute to his own incrimination).

In our opinion, although the case law of the ECtHR in many cases (*Funke v. France*), (*Serves v. France*) has condemned the ignoring by national courts of the privilege against self-incrimination and the right of the accused to remain silent, nevertheless, according to its specifics, the crime of leaving the scene of a road accident must constitute an exception. However, if in the case of other crimes (theft, rape, causing serious injuries, etc.) the offender's stay at the scene is neither necessary nor logical, because his physical condition during the commission of the crime does not matter (drunkenness, for example) and he cannot be forced to save his victim or wait for the owner to return the stolen property (this can also be the case in the case of renouncing the crime), in the case of the crime of leaving the scene of a road accident this has a completely different nature.

Having clarified these, we remind you that according to French law the crime of leaving the scene of a road accident consists of voluntarily escaping from the scene of an accident that has just been caused, this crime being very severely punished by law. The crime expressed by fleeing, (the action of leaving the scene of a road accident) according to the definition given by the French penal code is the case when a driver involved in a traffic accident decides to leave the scene of the collision in order to avoid civil and/or criminal responsibilities.

Similar to Romanian legislation, French legislation also provides for some obligations for the driver of the vehicle involved in the accident in the content of the Highway Code, being strictly correlated with the provisions of the Criminal Code in case of their non-execution.

Thus, the basis for applying the criminal penalty for committing the crime of leaving the scene of a road accident is the result of objective and necessary elements dependent on the driver involved, expressly provided for by the Highway Code.

The first refers to the fact that in the event of a clear and obvious accident he is obliged to notify the police right on the spot.

A second situation, but which constitutes an exception to the crime, is that of a minor collision, where the driver can continue driving without noticing the incident. In these circumstances, he cannot be accused of the accident and abandonment.

In this context, it should also be noted that the crime of leaving the scene of a road accident is considered consummated and liability applies to the perpetrator even if:

- the perpetrator compensated the victim for the damages;
- the victim withdrew his complaint;
- the accident was insignificant and did not cause significant damage.

As mentioned above, to avoid being accused of causing the accident and leaving the scene of the accident, the driver is required to stop on his own without the intervention of law enforcement and immediately make his identity known.

When individualizing the punishment for committing the crime of causing a road accident and leaving the scene of the crime, if serious consequences resulting in death by negligence have occurred, the perpetrator may also be accused of committing the crime of murder. If, as a result of the accident, the victim has lost his or her ability to work for a period exceeding three months or completely, the offender will be additionally punished for this as well.

Thus, according to French law, committing a road accident and voluntarily leaving the scene of the accident are serious crimes punishable by imprisonment for a term of up to 10 years, including a fine. In conclusion, the analysis of the provisions of the French Criminal Code on the researched topic allows us to understand the diversity of actions that are imposed on the driver after committing a road accident, the reason for the French legislator to criminalize this act, having the conviction that it hinders the administration of justice, as well as some doctrinal opinions that contradict this idea.

Specifically, in the last mentioned respect, we identify contradictory opinions according to which by forcing the driver of the means of transport to remain at the scene, he will indirectly incriminate himself, depriving himself, in one way or another, of the opportunity not to be accused.

Another state that criminalizes the act of leaving the scene of a road accident is Germany, whose criminal legislation stipulates that any person who caused a road accident or indirectly contributed to its occurrence has the obligation to identify themselves to the victim or other persons present at the scene.

If the victim is not present at the scene, as in the case of accidents in parking lots, then he is obliged to wait for a period of time until the owner of the respective car arrives, or to report this fact to the nearest police station. Violation of these rules entails criminal liability for the offense provided for in Article 142 of the German Criminal Code "Illicitly leaving the scene of a road accident" and is punishable by imprisonment for up to 3 years or a fine.

We therefore observe that German law is quite severe regarding the act of leaving the road, being penalized even the act of leaving the accident committed in the parking lot, where there are no victims, but the danger is not the same as in the case of the one produced in road traffic. In our opinion, the severity shown is exaggerated, being necessary to limit, in this case, only to the contraventional liability with the application of a more significant fine.

Among the member countries of the European Union, most of them, such as Greece, Portugal, Spain, do not consider the action of leaving the scene of a road accident as a crime, these actions being sanctioned in terms of failure to provide assistance or leaving someone in danger.

Leaving the scene of a road accident in the Czech Republic qualifies as a misdemeanor (if there are no bodily injuries) and as a crime if the accident results in bodily injuries.

However, in the criminal law of the country in question, the act of leaving the scene of a road accident is absorbed by that of failing to provide medical assistance. Specifically, according to Art. 151 of the Czech Criminal Code "a driver of a vehicle who, after a road accident in which he was involved, fails to provide the necessary assistance to a person who has suffered bodily injuries in the accident, even if he can do so without endangering himself or other persons, shall be punished by imprisonment for a term of up to five years or by a ban on exercising an activity" (Czech Criminal Code, No. 40/2009). Moreover, leaving the scene of a road accident in the Czech Republic goes beyond the limits of sanctioning for a misdemeanor or a crime, bringing implications also in the matter of civil liability for damages, respectively in the field of compulsory insurance for damages caused by a road accident. In other words, if the perpetrator leaves the scene of a road accident, he becomes responsible for compensating the victim, regardless of whether he is guilty of the accident or not, operating here a presumption of guilt for civil damages.

As an eloquent example, on 22 October 2019, an employee of the defendant caused a road accident and subsequently left the scene of the accident without a justified reason. The insurance company (the claimant) paid the injured person insurance benefits in the amount of CZK 110,022 and subsequently filed a claim for compensation against its employee under Article 10, paragraph 1, letter a. c) of Act No. 168/1999 Coll., on motor third party liability insurance (Judgment of the Supreme Court of the Czech Republic, file No. 23 Cdo 2700/2023).

So, we note that the Czech criminal law punishes the act of leaving the scene of a road accident, but focuses only on the social danger generated by the fact of not providing assistance to the victim, but also sanctions other adverse effects of the accident, such as civil damages, being automatically placed in the charge of the person who left the scene, without raising the issue of his guilt for the accident. Another issue that is not identified in our criminal legislation is that the perpetrator of a road accident is obliged to remain at the scene of the crime and provide assistance to the victim, only if this does not endanger his life and health. For example, if after the accident it is obvious and imminent that a fire will break out in the damaged car, the perpetrator may be exempted from the obligation to intervene, if this endangers his life and health.

According to Polish criminal law, fleeing the scene of an accident in itself does not constitute a separate crime under the Criminal Code, being considered a circumstance that aggravates the punishment for an already committed crime.

That is, committing a road accident in Poland will not be penalized under art. 177 if the driver leaves the scene of the crime, but under art. 178, this being an aggravating factor of the act of committing a road accident, punished to the same extent as the act of committing a road accident while intoxicated. Thus, according to art. 178. § 1 of the Polish Criminal Code, upon conviction of a perpetrator who committed an offence provided for in Article 173 § 1 or 2, Article 174, Article 177 § 1 or 2a, Article 178c § 1 point 2 or Article 178d, while intoxicated or under the influence of a narcotic substance, or who fled the scene of the incident, consumed alcohol or took a narcotic substance after committing the act provided for in Article 173 § 1 or 2, Article 174, Article 177 § 1 or 2a, Article 178c § 1 point 2 or Article 178d, and before subjecting him to an examination by an authorised body to determine the alcohol content or the presence of a narcotic substance in his body, the court shall apply the prison sentence provided for the offence charged (Criminal Code of Poland, No. 88/1997).

Bulgarian criminal law criminalizes leaving the scene of a road accident in Chapter XI (Crimes of general danger), Section II (Crimes against transport and telecommunications).

Similar to Polish legislation, in Bulgaria the crime of leaving the scene of a road accident is not regulated separately, but as an aggravating form of the crime of violating traffic safety rules.

Thus, under Art. 342 para. (1) of the Bulgarian Criminal Code, violation of traffic rules while driving a rolling stock on railways, an aircraft, a motor vehicle, a vessel, a combat vehicle or a special machine, which resulted in bodily harm or death of another person, is punishable by imprisonment for up to two years.

According to paragraph (2), the same punishment applies to a transport worker or official who violates the operating rules or quality requirements regarding the repair of rolling stock, roads or equipment, allowing bodily harm or death to occur (Bulgarian Criminal Code).

And yet, in the criminal law of Bulgaria, leaving the scene of a road accident is considered an aggravating circumstance of the crime provided for in art. 343 para. (1) of the Criminal Code, which stipulates that if the act was committed while intoxicated or as a result of the consumption of narcotic substances or their analogues, or if the bodily harm or death of more than one person occurred, or if the perpetrator fled the scene, or drove the vehicle without having the necessary capacity according to the law, or if it occurred at a pedestrian crossing, the perpetrator is punished with:

- a) imprisonment from one to six years - in case of serious or medium bodily harm; with imprisonment from two to ten years - in especially serious cases;
- b) imprisonment from three to fifteen years, and in especially serious cases - in case of death; with imprisonment from five to fifteen years - in particularly serious cases.

We are particularly curious about examining the criminal regulations in the Baltic states, which currently promote European values in terms of legislation, but at the same time retain some features inspired by Soviet legislation from the past, taking into account the fact that at a certain period in history they were countries of the ex-Soviet space.

So, the Finnish Criminal Code provides for liability for leaving the scene of a road accident in Chapter XXIII (Road Traffic Offences).

According to the criminal norm, the driver of a motor vehicle or a tram, who is a party to an accident and fails to stop immediately and assist the injured person within the limits of his/her abilities, shall be convicted of leaving the scene of a traffic accident, punishable by one year of imprisonment or a fine, unless a more severe punishment is provided for by law for the same act (Finnish Criminal Code).

What is noteworthy here is that the Finnish legislator obliges the perpetrator to help the injured person only based on his own abilities, leaving him the alternative of not intervening if he does not have certain abilities dictated by the circumstances in which the accident occurred (he cannot swim, for example, or does not know how to unlock the door, provide medical aid, etc.). However, as is also stated in the specialized literature, "the obligation to assist is imposed in order to respect the victim's right to life, but at the same time ensures respect for the person's freedom through the limiting obligation expressed by the fact that the legislator imposes assistance within the limits and options that the perpetrator has" (ȚICAL, G. M., CHIRUȚA A., 2019).

In this context, we identify Finnish legislation as being more permissive, but also more comprehensive in terms of the categories of interests it seeks to protect, in the sense that it not only aims to ensure the documentation of the perpetrator, but also to give the victim of the road accident a chance of survival by providing medical aid by the perpetrator, the first on the scene, even if his guilt for the accident has not yet been proven. Moreover, the escape from responsibility merges with leaving the person in danger in the same criminal norm, while avoiding, at the same time, the problem of double punishment for one and the same act.

A similar opinion is also found in the national doctrine, where it is considered that "the regulation of the crime of leaving the scene of a road accident by Finnish legislation is more balanced and proportionate to the fundamental principles of criminal law, because it expressly provides that the person is convicted for leaving the scene of a road accident, except in the case where a more severe punishment is provided for the same act by another article, which excludes the possibility of being held criminally liable twice for one and the same act" (ȚICAL, G. M., CHIRUȚA A., 2019).

It should also be noted here that the phrase "fails to stop immediately" (contained in art. 23, Finnish Penal Code) identifies some exceptions that lead to the driver of the vehicle being exempted from liability in cases where he fails to stop immediately:

- due to technical defects in his vehicle or a defect resulting from the accident;
- due to his health condition resulting from the impact;

- due to the failure to cause a collision, in the event of a minor accident.

From the norm analyzed above, it is observed that the perpetrator is obliged to help the injured person in conditions consistent with his own abilities, otherwise being subject to the risk of criminal punishment.

Such an obligation towards the person is also imposed by the Finnish legislator in Chapter XXI "Homicide and Bodily Injury", Section XV - Failure to intervene for the purpose of saving another person, which implies that a person who knows that another person is in danger of death or in serious danger to his health and does not provide or does not seek to obtain the assistance or support that can be reasonably expected from him, taking into account the options available to him and the nature of the situation, is punished with a fine or a maximum of six months' imprisonment for failure to intervene for the purpose of saving another person.

The obligation to assist is imposed in order to respect the victim's right to life, but at the same time it also ensures respect for the person's freedom through the limiting obligation expressed by the fact that the legislator imposes assistance within the limits and options that the perpetrator has.

However, we would also have to report some defects of the norm examined in Finnish legislation, namely, the fact that the legislator does not provide for the degree of bodily injuries that may arise from the accident. Thus, upon extensive examination of the norm, we can see that regardless of the degree of injuries caused by the accident, the guilty driver will be criminally punished. This admitted position somewhat violates the person's right to a fair trial.

In the Estonian criminal law, the crime of leaving the scene of a road accident was not initially provided for, as we did not identify in the content of the special part of the Estonian Criminal Code of 2002 a section that would criminalize crimes in the field of transport. The respective acts were provided for in Chapter XI (crimes against public security and public order), namely, by art. 204 of the Criminal Code, the violation of traffic safety rules or the operation of mechanical transport by the person driving the mechanical transport was sanctioned, and art. 205 of the Criminal Code of Estonia criminalized other violations of traffic safety rules and the operation of means of transport.

After 2005, the Estonian legislator decided to dedicate a separate section to road transport crimes (Chapter XXIII - culpable acts in the field of traffic safety).

Specifically, Article 423² of the Estonian Criminal Code provides for liability for the crime of consumption by the driver of a means of transport of alcohol, narcotic or psychotropic substances after violating the rules of traffic or operation of means of transport, committed with the reckless causing of serious damage to health or even death of a person, as well as leaving the scene of a road accident, an act punishable by imprisonment for up to five years (Estonian Criminal Code).

However, what is specific to Estonian legislation is that some criminal acts arising from the commission of a road accident are punished by special law. According to art. 236 of the Law in question (Law no. 44/2001), the act of failing to report a road accident is punishable by a fine of up to 300 conventional units, arrest or deprivation of the right to drive a means of transport for a period of up to 12 months.

Article 237 of the Law under consideration expressly provides for criminal liability for leaving the scene of a road accident or leaving in danger without providing first aid to the victims of a road accident, the perpetrator being punished with a fine of up to 300 conventional units, arrest or deprivation of the right to drive a means of transport for 24 months.

In the content of the presented norms, we identify the idea of criminal sanctioning the person who caused a road accident, and subsequently did not notify the police, did not provide assistance to the victims and left the scene of the road accident. So, we note that the methods of committing this crime are much more extensive than is provided for in the legislation of other states, including that of the Republic of Moldova.

We would agree with this incrimination tactic, but we believe that not informing the police about the accident would not be rational to provide grounds for the application of criminal liability. Moreover,

the parties can resolve the conflict generated by a road accident amicably without the need for the intervention of law enforcement agencies or the insurer on site.

The Criminal Code of Lithuania does not enshrine a separate norm for sanctioning the act of leaving the scene of a road accident, although it contains a section intended to criminalize acts against road safety (Chapter XXI).

However, the lack of a specific norm for this category of acts does not leave the perpetrator who flees from the scene of a road accident without sanction, leaving the victim in danger.

Thus, according to Art. 141 of the Criminal Code of Lithuania (Leaving in Danger), it is a crime to fail to provide necessary assistance to a victim in a life-threatening situation, an action that led to the victim's death or other serious consequences, an act that is punishable by unpaid work or a fine in the amount of up to five minimum wages (Criminal Code of the Republic of Latvia, 1998).

Moreover, the same style of regulation is also characteristic of the criminal legislation of Latvia, where in the absence of a norm criminalizing the act of leaving the scene of a road accident, the provisions of Art. 144 of the Criminal Code of Latvia will apply.

So, based on the above-mentioned norm, if the person responsible for the care of the victim, having the possibility of providing first aid in life-threatening situations, did not provide the necessary assistance or alone created such a danger, he is guilty of a crime and is punished by a fine or deprivation of liberty for a term of up to two years (Criminal Code of Lithuania, 2000).

Conclusions

Leaving the scene of a road accident has a certain diversity in its legal approach, as well as the doctrinal one, starting from the diversity of styles of regulation of this category of acts, to the avoidance of considering it as a crime. However, in some criminal legislation the act in question is incriminated distinctly, as an autonomous crime, and in others as a special form of leaving in danger. However, we identify norms in the Criminal Codes of many European states that sanction the act of leaving the scene of a road accident, contained in the sections that deal with crimes that attempt to obstruct the administration of justice, which indicates the categories of social relations that this attempts.

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CONTROLLED DELIVERY IN COMBATING POSTAL SMUGGLING: BETWEEN PROCEDURAL EFFICIENCY AND THE REQUIREMENTS OF ARTICLE 8 OF THE EUROPEAN CONVENTION ON HUMAN RIGHTS

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Abstract: *The exponential growth of cross-border e-commerce and the rapid expansion of international postal flows have transformed small parcels into a preferred vector for the smuggling of narcotics, tobacco, counterfeit goods and other prohibited items. In this context, controlled delivery, referred to in the legislation of the Republic of Moldova as (controlled delivery) and in Romanian legislation as (supervised delivery), has become one of the most efficient special investigative techniques, enabling the authorities to trace illicit consignments up to their final addressees, rather than seizing them at the customs border. The present study analyses the dual nature of this technique, situated at the intersection between procedural efficiency and the fundamental right to respect for correspondence enshrined in Article 8 ECHR. Drawing upon the legislation of the Republic of Moldova and Romania, EU instruments (Naples II, Regulation 515/97, the 2000 EU Convention) and UN standards (the Palermo Convention, the WCO Nairobi Convention), as well as on the case-law of the European Court of Human Rights (Klass, Malone, Iordachi, Roman Zakharov) and of the national courts, the article identifies the normative safeguards required by the Convention: a foreseeable legal basis, prior judicial oversight, proportionality, subsequent notification, and proposes de lege ferenda solutions for harmonising domestic provisions with the European procedural acquis.*

Keywords: *controlled delivery; postal smuggling; special investigative techniques; Article 8 ECHR; customs offences; judicial cooperation in criminal matters.*

JEL: K14, K33, K42

Introduction

The globalisation of e-commerce and the unprecedented growth in the volume of international postal items have transformed the postal system from a mere means of interpersonal communication into a global logistical channel for commercial exchanges, sometimes of an illicit nature. According to data published by the Universal Postal Union and the World Customs Organization, cross-border flows of small parcels have shown an annual increase of approximately 20% over the past decade, which has substantially heightened the exposure of customs borders to the introduction, through postal items or express courier services, of narcotic substances, untaxed tobacco products, counterfeit goods, weapons and chemical precursors [1]. This reality has brought to the fore the need for special investigative techniques capable of going beyond the traditional logic of border interception and tracing the criminal chain up to its end-beneficiary.

Discussion

Within such an investigative architecture, the technique known in Romanian terminology as *livrarea supravegheată* (supervised delivery) and in Moldovan terminology as *livrarea controlată* (controlled

delivery) constitutes the most efficient instrument for documenting cross-border offences committed through postal items [2]. It enables the national authorities, in cooperation with their counterparts in the States involved, not to seize illicit goods upon initial detection, but to allow them to circulate under surveillance, with or without substitution of the contents, up to the final addressee, thereby creating the possibility of identifying the entire criminal network.

The technique under analysis, however, entails a structural interference with two fundamental rights guaranteed by Article 8 of the European Convention on Human Rights: the right to respect for correspondence and the right to respect for private life. Postal correspondence has been specifically protected ever since the foundational case *Klass and Others v. Germany* [3], and subsequently, in cases such as *Malone v. United Kingdom* [4] and *Iordachi and Others v. Moldova* [5], the Strasbourg Court has set out strict requirements of foreseeability, necessity in a democratic society, and independent judicial oversight.

The motivation for this research lies precisely in this dual valence: on the one hand, the imperative of procedural efficiency in combating a dynamic and transnational criminal phenomenon; on the other hand, the obligation of States to keep interferences with postal correspondence within the bounds of a democratic order.

The specific objectives of the study are the following: the conceptual delimitation of controlled delivery and its positioning within the system of special investigative techniques; the comparative analysis of the regulations in force in the Republic of Moldova and Romania, with reference to European Union instruments and United Nations standards; the assessment of the compatibility of national rules with the requirements of Article 8 ECHR; the identification of the practical problems raised by the application of the technique in postal smuggling cases; and the formulation of *de lege ferenda* proposals.

Methodologically, the research relies on the legal-logical method, on the comparative method and on case-law analysis. The synthesis of the research stage reveals that, although the English-language specialised literature [6] has addressed controlled delivery in the context of cross-border cooperation, the specific approach to its application in customs cases involving postal items remains insufficiently developed in domestic legal scholarship, which justifies the present endeavour.

Controlled delivery is, in essence, a special technique of surveillance and investigation by which the competent authorities knowingly and in a coordinated manner allow the entry, transit or exit from the territory of a State of goods in respect of which there exists a reasonable suspicion of an illicit character, with a view to identifying the persons involved in the criminal chain.

The definition adopted at international level in Article 2(i) of the United Nations Convention against Transnational Organised Crime, signed at Palermo in 2000, enshrines this technique as the method consisting in allowing illicit or suspect consignments to pass out of, through or into the territory of one or more States, with the knowledge and under the supervision of the competent authorities, with a view to investigating an offence and identifying the persons involved in its commission [7].

In Romanian law, the technique is currently regulated under Article 151 of the Code of Criminal Procedure [8], having been elevated from its earlier status as a special procedure under the law on drug trafficking to the rank of a general institution of criminal procedural law [9]. Its scope of application extends not only to drugs, but also to weapons, explosive and nuclear materials, stolen items, sums of money and any goods resulting from illicit activities or destined for the commission of offences. In the Republic of Moldova, the regulation is contained in Article 138² of the Code of Criminal Procedure, the technique bearing the name *livrare controlată* (controlled delivery), a terminological variant influenced by the post-Soviet legislative model but with a normative content substantially similar to the European one [10].

The substantive condition common to both regulations is the existence of a reasonable suspicion as to the illicit character of the goods and, cumulatively, the impossibility of identifying the persons

involved by other, less intrusive investigative methods, a requirement that reflects the principle of subsidiarity, developed by the European Court in its consistent case-law concerning special measures. From a doctrinal perspective, controlled delivery has a dual legal nature. On the one hand, it is an evidence-gathering procedure, since its results, including the content of conversations intercepted during the operation and the discoveries made upon delivery of the parcel, are used as means of evidence in criminal proceedings.

On the other hand, it constitutes a procedural measure with effect on the circulation of goods, since it functionally suspends the rule of immediate confiscation of illicit goods discovered at the customs border. This dual nature explains why, in both Moldovan and Romanian law, the authorisation of the technique is entrusted to the prosecutor, who verifies both the formal lawfulness and the operational necessity of the measure, while its actual implementation is, as a rule, carried out by police bodies or by customs authorities with investigative competences.

Within this architecture, postal items present specific features which differentiate the controlled-delivery technique applied in this context from that used in road, rail or commercial air transport. The postal item is, by definition, confidential, the secrecy of correspondence being guaranteed both by Article 28 of the Constitution of Romania and by Article 30 of the Constitution of the Republic of Moldova, as well as by the Convention of the Universal Postal Union. Consequently, any interference with the contents of a postal item falls directly within the scope of Article 8 ECHR, since the protection afforded by this Convention provision covers the entirety of correspondence, without distinguishing between the ideational and the material content of parcels [11].

To this is added the fact that the operation requires the cooperation of authorities with distinct legal status, namely the customs authority, which carries out the initial physical and documentary control; the criminal investigation body, which documents the facts; the prosecutor, who exercises judicial control over the measure; and the postal operator (Poșta Moldovei, Poșta Română or private providers such as DHL, FedEx, DPD), which ensures the continuity of the parcel's transport. This multi-institutional architecture raises issues of procedural coordination, including in respect of liability for any incidents occurring in the course of delivery.

The threshold for triggering surveillance has, in the case of postal items, a particular specificity. It is generally activated as a result of the application of risk-analysis criteria to the advance data transmitted to customs by the postal operator, namely the information contained in CN22/CN23 declarations, in the electronic postal manifest and in the Entry Summary Declaration (ENS), regulated at EU level since 1 October 2021. Modern X-ray scanning techniques and specialised detectors, including drug-detection dogs, complete this preliminary analysis.

Thus, unlike other contexts in which controlled delivery is grafted onto an investigation already under way, in postal cases it is frequently initiated *ex nihilo*, on the basis of a suspicion shaped exclusively as a result of routine customs control.

From a technical standpoint, the operation typically comprises several consecutive stages: detection of the suspect parcel and collection of a sample for laboratory analysis, a central element in drug-trafficking cases; total or partial substitution of the illicit content with inert substances, a procedure which raises delicate questions concerning the integrity of the evidence; resealing the parcel and continuing transport to the addressee; interception of communications between the addressee and possible accomplices, including through the use of an undercover investigator acting as courier; surveillance of the actual handover and execution of the subsequent home search on the basis of authorisation by the judge for rights and liberties [12].

At the European Union level, the normative framework for controlled delivery in customs matters is built on several complementary tiers.

The first is represented by the Naples II Convention [13], which entered into force on 23 June 2009 and which regulates expressly, in Chapter IV, controlled deliveries defined as illicit consignments

which are not seized at the border but pursued up to their final destination, and which establishes the obligation of Member States to grant each other mutual assistance.

A second instrument is Council Regulation (EC) No 515/97 [14], subsequently amended by Regulation (EU) 2015/1525, which establishes the Customs Information System and the data-exchange mechanism through Container Status Messages, enabling the European Anti-Fraud Office (OLAF) to coordinate controlled-delivery operations between the customs authorities of the Member States.

A third tier is represented by the Convention of 29 May 2000 on Mutual Assistance in Criminal Matters between the Member States of the European Union [15], whose Article 12 enshrines the obligation of each Member State to allow controlled deliveries on its territory at the request of another Member State. The regime was subsequently complemented, in the relations between EU Member States, by Directive 2014/41/EU on the European Investigation Order [16], which permits the issuance of a European Investigation Order for the carrying out of a controlled delivery, with harmonised procedural safeguards.

At the international-law level, the principal pillar is the United Nations Convention against Transnational Organised Crime (Palermo, 2000) [7], whose Article 20 obliges States Parties, to the extent that the fundamental principles of their internal legal systems so permit, to take the necessary measures for the appropriate use of controlled deliveries. The Convention is supplemented by the United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances (Vienna, 1988) [17], which contains similar provisions on controlled delivery of drugs, and, in the customs sphere, by the Nairobi International Convention of 9 June 1977 [18], under the auspices of the World Customs Organization, which enshrines the technique of controlled delivery as a standard instrument of inter-State cooperation. For the Republic of Moldova, in the absence of EU Member State status, these instruments operate predominantly through the EU-Moldova Association Agreement of 27 June 2014 [19] and through bilateral agreements with Member States, while the acquisition of candidate-State status (December 2023) will significantly modify the framework of cooperation in the customs field.

The European Court of Human Rights has developed, over more than five decades of case-law, a consolidated body of jurisprudence concerning interferences with the right to respect for postal correspondence. The foundational judgment is *Klass and Others v. Germany* [3], in which the Grand Chamber held that the mere existence of legislation authorising secret surveillance creates a threat to the freedom of communication between users of postal and telecommunications services, constituting in itself an interference with the rights protected by Article 8.

This principle was subsequently consolidated in *Malone v. United Kingdom* [4], which clarified that the interference is lawful only where there is a basis in domestic law that is accessible to the person concerned and foreseeable in its effects, compatible with the requirements of the rule of law. The most relevant case for our legal area is, however, *Iordachi and Others v. Moldova* [5], in which the Court found that the system of secret surveillance in the Republic of Moldova was, in its own words, at the very least over-used, a fact attributable in part to the inadequacy of the safeguards contained in the law.

Although the judgment concerned the interception of telecommunications, its reasoning applies *mutatis mutandis* to any form of secret surveillance of postal correspondence, since the standard of foreseeability of the law is identical.

In *Roman Zakharov v. Russia* [20] and *Centrum för rättvisa v. Sweden* [21], the Grand Chamber systematised the six minimum safeguards which any law authorising interferences with correspondence must contain: the nature of the offences capable of triggering the measure, the definition of the categories of persons concerned, the establishment of a maximum duration, the procedure for examining, using and storing data, the precautions for communicating data to third parties, and the circumstances in which the data must be erased or destroyed. These standards operate

as a benchmark for assessing the compatibility of any national regulation governing controlled delivery of postal items.

Applying these benchmarks to the Moldovan and Romanian regulations, both systems provide for prior authorisation by the prosecutor rather than by a judge, a solution which may raise reservations from the perspective of the requirement of independent judicial oversight. The case-law of the ECtHR, particularly in *Dumitru Popescu v. Romania* (No. 2) [22], has nevertheless accepted that even a non-judicial authority may qualify as independent if it is sufficiently separate from the executing body, a criterion which the prosecutor satisfies, although with reservations, in systems with a public prosecution service integrated into the executive authority.

A separate issue remains the subsequent notification of the person concerned, since once the operation has been completed and the maintenance of secrecy is no longer necessary, the person should be informed in order for an effective remedy to be possible. In situations where the operation ends without identifying the addressee, the sender frequently remains outside any notification mechanism, even though their correspondence has been the object of an interference [23].

Judicial practice confirms these concerns. In Romania, the Constitutional Court examined, in Decision No. 51/2016 [24], the issues concerning the technical surveillance warrant, ruling that the phrase "or of other specialised bodies of the State" contained in Article 142(1) of the Code of Criminal Procedure is unconstitutional; in Decision No. 244/2017 [25], the Court found the necessity of an effective remedy against technical surveillance measures for persons concerned who do not have the status of defendant.

These decisions, although they do not directly address controlled delivery, configure the procedural safeguards applicable to any special technique involving interferences with private life. As regards smuggling, the High Court of Cassation and Justice, by Decision No. 32/2015 of the Panel for the resolution of legal issues in criminal matters [26], published in Official Gazette No. 62 of 28 January 2016, clarified the notion of "smuggling" used in Article 270(3) of the Customs Code, holding that this notion covers both the introduction of goods through places other than those designated for customs control and their introduction by way of evading customs control, an interpretation relevant to the legal qualification of the facts uncovered as a result of postal controlled-delivery operations.

In the Republic of Moldova, the Prosecutor's Office for Combating Organised Crime and Special Cases has reported a significant increase in the number of authorised controlled deliveries in recent years [27], a trend which reflects both the intensification of international postal flows and the consolidation of operational capacities of law-enforcement bodies. The cases concluded illustrate both the offensive potential of the technique and the difficulties of procedural coordination in a multijurisdictional context, including the controversial issue of the action of Moldovan authorities on territories over which the State does not exercise effective sovereignty, an issue specific to the Transnistrian context.

A critical observation must be made concerning the absence, in both jurisdictions, of decisions of the higher courts in which the compatibility of the regulation of postal controlled delivery with Article 8 ECHR has been expressly analysed, which leaves the interpretive and doctrinal space open.

Such reflections are completed, on the institutional plane, by observations on the way in which procedural cooperation translates into the day-to-day practice of law-enforcement bodies. Effective coordination presupposes not only coherent legislation, but also the existence of permanent communication channels between the customs authorities, the public prosecution, the police and the postal operators, supported by clear inter-institutional protocols. In the recent experience of the two States, it has been noted that, although the normative framework is similar, operational performance differs significantly depending on the degree of digitalisation of data flows and on the quality of professional training of the personnel involved. These differences are visible above all in the speed of reaction, the quality of the evidence administered and the rate of completion of operations resulting in actual indictment.

The analysis of practice reveals, on the operational plane, several recurring problems which affect the efficiency of the technique.

A first problem is that of substitution of the parcel's contents. In both Moldovan and Romanian law, the legislation permits the total or partial substitution of illicit goods, but does not detail the technical standards regarding the integrity of the seal, the chain of custody of the substance extracted for analysis and the resealing procedure. In the absence of normalised procedures, the defence may subsequently invoke, on the basis of Article 6 ECHR, a breach of the right to a fair trial through alteration of the *corpora delicti*.

A second problem is that of refused controlled deliveries, where the addressee fails to appear to collect the parcel either for reasons beyond their control or because of suspicions induced by delays in delivery, a situation which significantly erodes the possibility of identifying the entire criminal chain.

A third challenge is of a technological nature: the increase in the volume of small parcels valued under EUR 150, apparently exempted from complex customs formalities, has transformed this category into a preferred vector for small-scale but frequent trafficking, and current risk-analysis regulations are insufficiently calibrated to detect repetitive flows of small parcels coming from the same sender or destined for the same addressee [28].

To this is added the fact that, in the case of EU Member States, the European Investigation Order mechanism [16] significantly facilitates cooperation, whereas the Republic of Moldova, not participating in this instrument, must resort to bilateral mechanisms or to the European Convention on Mutual Assistance of 1959, with slower and less foreseeable procedures, which creates operational asymmetries that may be exploited by criminal networks.

Conclusions

The analysis carried out allows for the formulation of several conclusions of theoretical and practical value. The first concerns the consolidated legal status of controlled delivery as a special investigative technique that is indispensable in the arsenal for combating smuggling through postal items. The existence of a domestic normative framework in both jurisdictions, namely Article 138² of the Moldovan CCP and Article 151 of the Romanian CCP, coupled with a coherent international framework comprising the Palermo Convention, the Naples II Convention and the EU Convention of 2000, provides the premises for a sound investigative practice.

The second conclusion concerns the structural compatibility of national regulations with the requirements of Article 8 ECHR, with the reservation that the case-law in *Iordachi v. Moldova* [5] sounds an alarm regarding the need for additional safeguards of foreseeability and oversight.

Thirdly, the asymmetry between the Romanian system, integrated into the EU's Area of Freedom, Security and Justice, and the Moldovan one, in the process of harmonisation, generates an additional operational cost for combating smuggling on the Republic of Moldova–EU route, a cost which will progressively decrease as the accession process advances. Fourthly, there is insufficient differentiation, at both normative and doctrinal level, between classical controlled delivery, targeting major commercial transports, and that applied to low-value postal items, even though both raise distinct procedural problems.

On the *de lege ferenda* plane, several adjustments are proposed. The first concerns the introduction, in both Article 138² of the Moldovan CCP and Article 151 of the Romanian CCP, of express provisions on the technical standards for the substitution of parcel contents, including the obligation of video recording of resealing operations, a measure intended to guarantee the integrity of the evidence and to prevent subsequent challenges. The second proposal concerns the establishment of a mechanism for subsequent notification of the parcel sender, in cases where the operation ends without criminal proceedings being initiated against them, in order to ensure compatibility with the case-law in *Pietrzak and Bychawska-Siniarska v. Poland* [23].

The third direction of reform consists in strengthening the framework of cooperation between the customs authority and the public prosecution, through the adoption of joint operational protocols defining objective thresholds for referring suspect parcels to the criminal investigation bodies. Fourthly, the development, in partnership with postal operators, of integrated risk-analysis platforms is required, which would enable the detection of cumulative flows of small parcels with a potentially criminal character.

Among the limitations of the present research are the lack of access to comprehensive statistical data on operations carried out in recent years in the Republic of Moldova, partially classified, and the relative rarity of judgments published *in extenso* on this topic. Future research could deepen, on the one hand, the empirical dimension, through surveys conducted among practitioners, namely prosecutors and customs criminal-investigation officers, and, on the other hand, the comparative dimension, by extending the analysis to the German, French and Italian systems, where the technique has generated consistent constitutional case-law.

Looking ahead, the relevance of the controlled-delivery technique will be dictated by the capacity of national legal systems to adapt to the technological transformations of postal trade. The emergence of globalised e-commerce platforms, the development of crypto-financial payment instruments and the appearance of automated logistical flows call for a rethinking of risk-analysis parameters [29] and of the criteria for triggering special operations. The balance between procedural efficiency and the protection of fundamental rights remains, in these conditions, a permanent objective of the legislator, and compliance with European standards in this matter is not an external constraint, but a benchmark for building an investigative system that remains credible in the eyes of citizens and international partners.

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DELIMITATION OF CONSTRUCTION-RELATED OFFENCES FROM OTHER ECONOMIC CRIMES IN THE REPUBLIC OF MOLDOVA: DOCTRINAL AND JURESPRUDENTIAL CRITERIA AND CHALLENGES OF LEGAL QUALIFICATION

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Abstract: *Construction-related offences constitute a distinct category within the broader spectrum of economic criminality, distinguished by their technical complexity and the interplay between administrative, civil, and criminal liabilities. The primary aim of this study is to examine the delimitation of these offences from other economic crimes in the Republic of Moldova, specifically fraud, abuse of office, and negligence. The research utilizes a doctrinal and jurisprudential methodology, relying on a comprehensive analysis of the Moldovan Criminal Code, relevant legislative acts, scholarly writings, and case law. Data sources include published judicial decisions, expert reports, and academic commentaries addressing the classification and qualification of construction offences. The study identifies key doctrinal criteria such as the nature of the protected social value, the form of guilt, and the specific subject of the offence and assesses their practical application in judicial practice. Findings indicate that overlapping elements between construction offences and other economic crimes often create significant challenges in legal qualification, particularly when acts involve both technical violations and fraudulent or negligent behaviour. The research further highlights the ambiguity of certain legislative formulations, including broad references to 'public interest' or 'damage,' which contribute to inconsistent judicial interpretation. Overall, the study concludes that effective delimitation requires clearer legislative definitions, systematic judicial guidance, and enhanced technical expertise within the judiciary. By addressing these gaps, the legal system can ensure more consistent enforcement and protection of both public safety and patrimonial interests in the construction sector.*

Keywords: *construction offences, economic crimes, fraud, abuse of office, negligence, legal qualification*

JEL: K14, K19, L74.

Introduction

The development of the construction sector in the Republic of Moldova has been accompanied by a notable increase in offences related to building activities, including illegal construction, substandard works, and violations of technical and safety regulations. These practices not only undermine public safety and urban planning standards but also generate significant economic and social consequences. In many cases, construction-related offences intersect with other economic crimes, such as fraud, abuse of office, or professional negligence, which complicates the process of legal qualification and enforcement. This overlap creates challenges for both doctrinal analysis and judicial practice, highlighting the need for a systematic approach to delimiting these offences within the broader framework of criminal law.

The motivation for choosing this topic stems from the practical and theoretical importance of ensuring legal clarity in the construction sector, which is critical for safeguarding public interest, promoting accountability, and preventing economic losses. Despite the growing relevance of these issues, there is a gap in the existing literature regarding the precise criteria for distinguishing construction offences

from other economic crimes in the Moldovan context, particularly in light of doctrinal debates and divergent judicial interpretations.

The primary goal of this research is to analyze the delimitation of construction-related offences from fraud, abuse of office, and negligence, through a combination of doctrinal review and jurisprudential examination. The study employs a qualitative methodology, relying on a detailed analysis of the Moldovan Criminal Code, legislative acts, scholarly writings, and selected judicial decisions. The research stage synthesized current knowledge on legal qualification, identifying key criteria such as the nature of the protected social value, the form of guilt, and the specific subject of the offence. The study also highlights the practical difficulties encountered by courts when multiple offences overlap, providing a foundation for proposals aimed at improving legal clarity and enforcement practices.

Basic content

The regulation of construction-related offences in the Republic of Moldova is primarily established by the art. 257 of Criminal Code of Republic of Moldova, particularly Article 257, which criminalizes the execution of low-quality, non-compliant, or otherwise unsafe construction works that may threaten public safety or cause significant material damage. These offences are distinguished by several specific characteristics:

Material object – the target of the offence generally involves buildings, infrastructure projects, or other construction works.

Special subject – the responsible parties often include engineers, project managers, or other professionals directly involved in planning, supervision, or execution.

Technical normative framework – these offences are closely tied to technical and construction standards, codes, and regulations that prescribe quality, safety, and compliance measures.

Unlike general economic crimes, which primarily concern financial or patrimonial interests, construction offences frequently involve technical violations, meaning the act itself endangers public safety or urban order rather than directly aiming for financial gain (State Report on Construction Compliance, 2025).

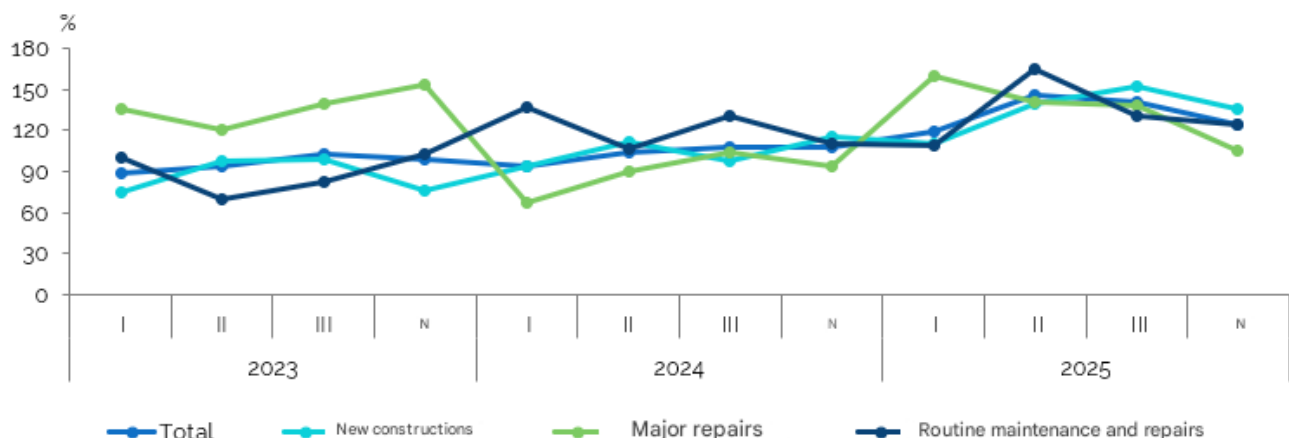


Figure 1. Volume indices of construction works executed, by structural elements, in 2023-2025 (by quarters), in % compared to the corresponding period of the previous year

Source: https://statistica.gov.md/ro/lucrari-de-constructii-executate-in-ianuarie-iunie-2025-9801_61936.html

According to Article 190 of the Criminal Code of the Republic of Moldova, fraud is defined as the unlawful acquisition of another person's property through the use of deception or by exploiting a relationship of trust. The fundamental elements of this offence include the employment of misleading actions or representations, the occurrence of patrimonial damage, and the existence of intent to obtain an illicit benefit (Criminal Code of the Republic of Moldova).

The differentiation between construction-related offences and fraud is grounded in several essential criteria that reflect both the legal nature of the act and the underlying intent of the perpetrator.

First, with regard to the purpose of the act, fraud is primarily characterized by the intention to obtain unlawful financial gain or enrichment. By contrast, construction offences are generally committed in the course of executing building works, even when such works fail to comply with legal or technical standards. In these cases, the objective is not necessarily illicit profit, but rather the completion of the construction activity, albeit in a defective or non-compliant manner.

Second, concerning the role of deception, fraud inherently requires the use of deceptive practices or the exploitation of trust as a central element of the offence. In contrast, construction-related offences may arise independently of any deceptive conduct, often resulting from breaches of technical regulations, professional errors, or non-compliance with established construction norms.

Third, the protected social value differs significantly between the two categories of offences. Fraud is primarily aimed at protecting patrimonial interests and property rights, whereas construction offences are designed to safeguard public safety, ensure structural integrity, and maintain compliance with urban planning and technical standards.

From a practical perspective, difficulties arise in situations where construction contracts involve misrepresentation of completed works or artificially inflated costs. In such cases, the factual circumstances may simultaneously satisfy the legal elements of both fraud and construction-related offences. Therefore, judicial authorities must carefully determine whether the deceptive conduct constitutes the core element of the offence or merely plays a secondary role in relation to technical violations (Constitutional Court, 2017).

According to Article 327 of the Criminal Code of the Republic of Moldova, abuse of office is defined as the deliberate and unlawful exercise of official powers by a public official, carried out in contradiction with the duties and obligations established by law, and resulting in harm to legally protected interests. This offence presupposes the existence of a special subject, namely a person vested with public authority or entrusted with the exercise of public functions, who intentionally deviates from the legal framework governing their conduct.

The essential elements of abuse of office include the misuse or excess of authority, the intentional nature of the act, and the occurrence of damage affecting either public institutions, the rights of individuals, or broader societal interests. The violation may consist in actions or omissions that contradict statutory responsibilities, demonstrating a conscious disregard for legal norms and professional duties.

Furthermore, the offence is characterized by a direct link between the improper use of official capacity and the resulting prejudice, whether material or non-material. In this context, the protected social values extend beyond patrimonial interests, encompassing the proper functioning of public administration, the integrity of public service, and the trust of citizens in state institutions.

Thus, abuse of office represents a serious infringement of legal and ethical standards in public administration, requiring a careful assessment of both the subjective element (intent) and the objective consequences (damage) in order to ensure correct legal qualification (Criminal Code of the Republic of Moldova, Art. 327).

The differentiation between abuse of office and construction-related offences is based on several fundamental doctrinal criteria, which reflect both the legal nature of the conduct and the characteristics of the individuals involved.

First, with respect to the subject of the offence, abuse of office is inherently limited to individuals who hold a public position or who are entrusted with the exercise of public authority. This category includes public officials or other persons performing functions of public interest, whose actions are governed by specific legal obligations. In contrast, construction-related offences are not restricted to such subjects and may be committed by private individuals, contractors, or corporate entities that operate outside the sphere of public authority.

Second, regarding the legal duty that is violated, abuse of office presupposes the infringement of obligations that are explicitly established by legal norms governing public service. The misconduct arises from the improper execution or deliberate disregard of duties "*granted by law*," reflecting a breach of the legal framework applicable to public administration. Conversely, construction offences typically involve the violation of technical rules, building codes, or regulatory standards specific to the construction sector, rather than statutory duties associated with public office.

Third, the nature of the damage constitutes another essential point of distinction. In the case of abuse of office, the harm primarily affects institutional interests, public administration, or the broader public interest, often undermining trust in state authorities. By contrast, construction-related offences generally produce consequences related to safety risks, diminished quality of works, and threats to the structural integrity of buildings and infrastructure. This distinction has been emphasized in judicial practice, including the jurisprudence of the Constitutional Court of Moldova, which highlights the importance of clearly identifying the protected social value in order to ensure proper legal qualification (Constitutional Court of Moldova, 2017).

According to Article 329 of the Criminal Code of the Republic of Moldova, negligence is defined as the failure of a person to duly perform their professional or service-related duties as a result of insufficient care, lack of diligence, or inadequate attention, in the absence of any intent to cause harm. This form of criminal liability arises when an individual, although bound by specific legal or professional obligations, does not meet the required standard of conduct expected in the exercise of their functions.

The defining feature of negligence lies in the absence of intent, as the harmful consequences are not deliberately pursued but occur due to imprudence, carelessness, or a failure to foresee risks that could reasonably have been anticipated. The conduct may manifest either through omission such as failing to take necessary precautions or through improper action that does not comply with established professional standards.

Furthermore, negligence presupposes the existence of a causal link between the inadequate performance of duties and the resulting damage, whether material or non-material. The offence typically affects the proper functioning of professional activities, institutional efficiency, or the protection of legally safeguarded interests.

Thus, negligence represents a breach of the duty of care imposed on individuals in the exercise of their professional responsibilities, requiring a careful evaluation of both the objective conduct and the subjective element namely, the lack of foresight or diligence in order to ensure correct legal qualification (Criminal Code of the Republic of Moldova, Art. 329).

The distinction between negligence and construction-related offences is primarily determined by several doctrinal criteria, which focus on both the subjective and objective elements of the conduct.

First, with regard to the form of guilt, negligence is characterized by the absence of intent, manifesting instead through imprudence, carelessness, or a failure to foresee foreseeable consequences. In contrast, many construction-related offences involve intentional conduct or a mixed form of guilt, where deliberate actions are combined with elements of negligence, particularly in situations where professionals consciously disregard applicable standards while underestimating potential risks.

Second, the presence of material interest represents a significant differentiating factor. From a doctrinal perspective, the pursuit of material gain is generally incompatible with negligence, as negligent acts lack the intentional component required for such an objective. Consequently, when evidence indicates that the perpetrator acted with the purpose of obtaining a financial advantage, the legal classification may shift toward offences such as abuse of office or other intentional crimes (Popenco, 2020).

Third, the degree and nature of the violation further contribute to the distinction. Negligence typically involves omissions, insufficient diligence, or failure to comply with professional standards due to inattention. By contrast, construction-related offences may involve the conscious and deliberate

disregard of technical norms, safety regulations, or quality requirements governing construction activities.

From a practical standpoint, significant challenges arise in the process of legal qualification. Deficiencies in construction quality may stem either from simple negligence such as design flaws or miscalculations or from intentional practices, including cost reduction strategies that compromise safety or compliance. In the latter case, criminal liability may extend beyond negligence to include construction-related offences or even fraud. Accurately distinguishing between these scenarios often requires specialized technical expertise, as well as a thorough analysis of the factual circumstances.

In light of doctrinal approaches and judicial practice, several general criteria for legal qualification can be identified. These include the nature of the protected social value (whether related to property, public safety, or institutional integrity), the form of guilt (intentional or negligent), the specific subject involved (public official or private actor), the means by which the act is committed (such as deception, abuse of authority, or technical violations), and the primary purpose underlying the conduct (profit-oriented versus the execution of construction works).

In situations where multiple legal norms appear applicable, the guiding principle is to apply the provision that most accurately reflects the true legal nature and substance of the act, ensuring a correct and consistent legal qualification in accordance with established doctrine and jurisprudence.

A major difficulty in the legal qualification of construction-related offences arises from the phenomenon of normative overlap, whereby these offences frequently intersect with other categories of economic crimes. In practice, the same factual situation may simultaneously exhibit elements specific to fraud, particularly in cases involving financial manipulation or misrepresentation of costs, abuse of office when public officials unlawfully authorize or tolerate non-compliant constructions, and negligence where there is a failure to adequately supervise or ensure compliance with technical standards. This convergence of legal provisions complicates the process of identifying the most appropriate legal classification and may lead to inconsistent judicial outcomes.

Another significant challenge is the ambiguity of legal norms, especially the use of broad and indeterminate concepts such as "*damage*" or "*public interest*." These notions lack precise legal boundaries, which creates a risk of divergent interpretations in judicial practice. As emphasized in the jurisprudence of the Constitutional Court (2017), the absence of clear and predictable definitions may undermine legal certainty and open the door to arbitrary or inconsistent applications of criminal law.

Furthermore, the technical complexity inherent in construction activities presents an additional obstacle for judicial authorities. Cases in this field often involve highly specialized knowledge related to engineering standards, building regulations, and safety requirements. As a result, courts are frequently dependent on expert opinions, which, although essential, may vary in quality or interpretation, thereby leading to differing conclusions and affecting the consistency of judicial decisions.

Finally, the principle of the subsidiarity of criminal law, reflected in its *ultima ratio* character, requires that criminal sanctions be applied only in situations where the degree of social harm justifies such intervention. However, in the construction sector, it is often difficult to clearly distinguish between administrative violations, civil liability, and criminal offences. This blurred boundary creates practical challenges in determining when criminal law should be engaged, highlighting the need for clearer criteria and more coherent legal regulation.

Table 1. Delimitation of Construction-Related Offences from Other Economic Crimes in the Republic of Moldova

Criteria	Construction Offences (Art. 257 CC RM)	Fraud (Art. 190 CC RM)	Abuse of Office (Art. 327 CC RM)	Negligence (Art. 329 CC RM)
Legal nature	Technical-economic offence related to construction activities	Economic offence against patrimonial relations	Service-related offence affecting public administration	Professional/service-related offence based on lack of diligence
Protected social value	Public safety, structural integrity, construction quality	Property rights and financial assets	Proper functioning of public administration and public trust	Proper performance of professional duties
Subject of the offence	Often special (engineers, builders, project managers), but may include legal entities	General subject (any person)	Special subject (public official or person exercising public authority)	Special subject (person with professional/service duties)
Form of guilt	Intent or mixed guilt (intent + negligence)	Direct intent (purpose of unlawful gain)	Direct intent	Negligence (imprudence, lack of care)
Purpose of the act	Execution of construction works (even if defective)	Unlawful enrichment	Obtaining benefits or causing damage through misuse of office	No purpose to harm; result of carelessness
Means of committing	Violation of technical norms and construction standards	Deception or abuse of trust	Misuse of official position contrary to legal duties (Constitutional Court of Moldova, 2017)	Failure to properly fulfill duties
Nature of damage	Physical damage, safety risks, infrastructure failure	Patrimonial damage	Damage to public or private legally protected interests	Damage caused by lack of diligence
Role of deception	Not required	Essential element	Not essential (may exist incidentally)	Absent
Material interest	Possible but not mandatory	Essential	Usually present (personal or third-party benefit)	Generally absent (Popenco, 2020)
Type of violation	Breach of technical and regulatory standards	Manipulation of facts or trust	Violation of legal duties granted by law (Constitutional Court of Moldova, 2017)	Omission or improper execution of duties
Typical practical situations	Poor-quality construction, unsafe buildings, non-compliance with standards	False contracts, financial deception	Illegal authorization of construction, tolerance of violations	Lack of supervision, design errors
Main delimitation difficulty	Overlap with fraud (false reporting) and negligence (technical errors)	Distinguishing deception from technical non-compliance	Distinguishing administrative fault from criminal misuse	Differentiating negligence from intentional misconduct

Source: Constitutional Court of Moldova, 2017; Popenco, 2020

Table 1. *Delimitation of Construction-Related Offences from Other Economic Crimes in the Republic of Moldova*, which presents the delimitation of construction-related offences from other categories of economic crimes in the Republic of Moldova, underscores that the fundamental distinctions between these offences are primarily based on two key factors: the protected social value and the form of guilt of the perpetrator. Construction-related offences are principally aimed at safeguarding public safety,

structural integrity, and compliance with technical and regulatory standards, whereas other economic crimes, such as fraud or abuse of office, are oriented toward protecting patrimonial interests, institutional integrity, or public trust. Similarly, the form of guilt whether intentional, negligent, or a combination thereof plays a decisive role in differentiating these offences, as it reflects the mental state and deliberate or inadvertent conduct of the actor.

Despite these doctrinal distinctions, practical challenges frequently emerge due to the overlapping factual elements inherent in many construction-related cases. For instance, acts such as false reporting of construction progress, cost inflation, or failure to supervise technical compliance may simultaneously exhibit characteristics of fraud, abuse of office, or negligence, complicating the process of legal qualification.

In accordance with the principles established under Moldovan criminal law, the correct legal classification of an act must be guided by its true legal nature, rather than relying on broad or extensive interpretation. Ensuring fidelity to the principle of legality requires that judicial authorities accurately identify the essential elements of the offence, weigh the intent and conduct of the perpetrator, and distinguish between overlapping norms. This approach guarantees consistency in enforcement, prevents arbitrary application of criminal provisions, and upholds the legal protection of both public interests and patrimonial rights within the construction sector.

Conclusions

The process of distinguishing construction-related offences from other types of economic crimes in the Republic of Moldova constitutes a highly intricate legal issue, reflecting the convergence of technical, economic, and administrative dimensions within the construction sector. While doctrinal and jurisprudential criteria such as the nature of the protected social value, the form of guilt, and the specific subject of the offence serve as important guides for legal classification, they are often insufficient to guarantee uniform and consistent application in practice. The overlapping elements of offences, coupled with ambiguities in legislative language and the technical complexity of construction activities, frequently create challenges for judicial authorities in determining the appropriate qualification of acts.

This analysis underscores the pressing need for several key improvements to enhance legal clarity and enforcement effectiveness. First, the adoption of clearer legislative definitions that precisely delineate the boundaries of construction-related offences would reduce interpretative uncertainty and provide a firmer basis for judicial decision-making. Second, specialized training for judges, prosecutors, and legal practitioners is essential to ensure that technical aspects of construction and engineering standards are properly understood and accurately assessed within criminal proceedings. Third, the development of a more coherent and harmonized jurisprudential approach would help to unify the interpretation of relevant norms, minimize discrepancies in case law, and strengthen the predictability of legal outcomes.

Only through the combined implementation of these measures can the principles of legal certainty and effective criminal enforcement be fully realized in the construction sector, ensuring the protection of public safety, structural integrity, and patrimonial interests while maintaining the integrity and credibility of the Moldovan legal system.

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MODELS OF CRIMINALIZATION OF FORCED MARRIAGE IN EUROPEAN CRIMINAL LAW

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Abstract: *Forced marriage remains one of the most serious violations of individual autonomy and human dignity, disproportionately affecting women and girls within European jurisdictions. This article undertakes a systematic comparative analysis of the legislative models through which European states have chosen to criminalize forced marriage, examining the legal architecture, definitional scope, and sanctioning regimes of each approach. Three principal models are identified and evaluated: the integrated model, in which forced marriage is prosecuted under pre-existing coercion or deprivation-of-liberty norms; the autonomous model, featuring a dedicated criminal offence with independent constituent elements; and the hybrid model, which grafts forced-marriage-specific aggravating circumstances onto existing coercion frameworks. Drawing on doctrinal legal analysis, normative comparison, and legislative history, the study surveys the criminal law of the United Kingdom, Germany, Belgium, Norway, Denmark, Switzerland, Austria, and France, as well as the obligations arising from Article 37 of the Council of Europe Istanbul Convention (2011) and the monitoring findings of the GREVIO expert body. The research demonstrates that autonomous criminalization, complemented by extraterritorial jurisdiction and victim-centered support mechanisms, produces the most effective protective outcomes. Significant gaps remain in definitional consistency, evidentiary standards, and cross-border cooperation. The article concludes by proposing core normative elements for an effective criminalization model and identifying directions for future comparative research and potential EU-level harmonization.*

Key words: *forced marriage, criminalization models, European criminal law, Istanbul Convention, gender-based violence, comparative criminal law*

JEL: K14, K33, K38

Introduction

Forced marriage constitutes a fundamental violation of individual autonomy and human rights, manifested through the coercion of a person into entering into a marriage without their free, informed, and full consent. Unlike arranged marriage, in which the parties ultimately give their consent, forced marriage involves the use of physical, psychological, economic, or cultural pressure, sometimes taking the form of fraud or abduction. The phenomenon predominantly affects women and girls; however, recent European statistics indicate a significant presence among male minors as well (FRA, 2023).

The criminal law relevance of the topic is amplified by two converging realities: on the one hand, the adoption of the Council of Europe's Istanbul Convention (2011), which imposed an explicit obligation on member states to criminalize forced marriage as a distinct criminal offense; on the other hand, the rise of "forced marriage tourism," whereby victims are taken to other states for the purpose of concluding a marriage, thereby circumventing the legal protection of their country of residence. Data from the European Union Agency for Fundamental Rights (FRA) in 2023 confirm that, between 2018 and 2022, over 2,800 cases of forced marriage were recorded in EU Member States, with a high estimated level of underreporting.

The objectives of this research are: (1) to identify and systematize legislative models for the criminalization of forced marriage in European criminal law; (2) to conduct a comparative analysis of the constituent elements of the offense across different legal systems; (3) to assess the effectiveness

of each model from the perspective of victim protection; and (4) to identify the essential normative elements of an effective model of criminalization. The methodology employs the doctrinal method, the comparative method, normative legal analysis, and the examination of GREVIO reports monitoring the implementation of the Istanbul Convention.

Basic content

Article 37 of the Council of Europe Convention on preventing and combating violence against women (CETS No. 210, Istanbul, 2011) obliges States Parties to criminalize two distinct acts: (a) coercing an adult or a minor into entering into a marriage; and (b) luring or retaining a person in the territory of another state for the purpose of forced marriage. The Explanatory Report to the Convention specifies that the notion of "coercion" must be interpreted broadly, encompassing psychological pressure, emotional blackmail, deprivation of freedom of movement, and the exploitation of a person's state of vulnerability (Council of Europe, 2011, paras. 191–195).

The Group of Experts on Action against Violence against Women and Domestic Violence (GREVIO), tasked with monitoring the implementation of the Convention, has found in its reports from 2019–2024 that the transposition of Article 37 remains uneven: some states have adopted specific criminal provisions, others continue to rely on general coercion-related offenses, while others apply intermediate solutions. This diversity constitutes the empirical framework of the present comparative analysis (GREVIO, 2024).

The integrated model is defined by the absence of a specific criminal provision on forced marriage, the act being prosecuted under general legal provisions concerning coercion, deprivation of liberty, threats, or exploitation. The main argument advanced by proponents of this model is that general criminal law provides sufficient tools, and that a distinct criminalization would create legislative overlap and legal uncertainty.

France continues to apply, with certain nuances, an almost integrated model: forced marriage is prosecuted through the concurrence of the offense of coercion (Article 222-33-3 of the French Criminal Code, introduced in 2010), the civil nullity of the marriage, and the possible retention of a minor abroad. Although the 2010 reform increased the penalty for coercion into marriage to three years of imprisonment and a fine, GREVIO noted in its 2019 report that France has not yet created an autonomous criminal offense, which limits the effectiveness of criminal prosecution (GREVIO, 2019).

The autonomous model presupposes the existence of a specific criminal provision, with its own definition of the act, distinct constituent elements, and an independent sanctioning regime. This model offers the advantages of legal visibility, clarification of evidentiary elements, and the delivery of an explicit normative message to society and potential perpetrators.

The United Kingdom has implemented the most developed autonomous system through the Anti-social Behaviour, Crime and Policing Act 2014, which criminalized forced marriage in both England and Wales, as well as in Scotland, with a maximum penalty of 7 years' imprisonment. UK law defines the offense both in terms of physical or psychological coercion and through fraud, while also providing for an explicit extraterritoriality clause applicable to British citizens and residents. In addition, the Forced Marriage (Civil Protection) Act 2007 introduced civil protection orders, thus creating a dual civil-criminal institutional response mechanism.

Germany adopted in 2011 §237 of the Criminal Code (StGB – Zwangsheirat), establishing an autonomous offense punishable by 6 months to 5 years' imprisonment, increased to at least 2 years when the victim is a minor. Prior to the reform, the act was prosecuted only under §240 StGB (general coercion). The new provision also includes the offense of transporting the victim to another state (§237(2) StGB), thereby giving effect to the obligation set out in Article 37(2) of the Istanbul Convention (Strafgesetzbuch, 2011).

Belgium criminalized forced marriage in 2013 through Article 391sexies of the Belgian Criminal Code, with penalties ranging from 1 to 5 years, increased in cases involving minor victims. A

distinctive feature of this provision is the explicit criminalization of three modalities: coercion, deception, and abuse of authority or of a situation of vulnerability the latter significantly broadening the scope of application and representing a relevant normative innovation for legal systems adopting the autonomous model (Belgian Criminal Code, 2013).

Norway (§253 of the Penal Code, punishable by up to 6 years' imprisonment) and Denmark (§260a of the Penal Code, 4 years) have served as reference models for European states, both adopting forced marriage as an autonomous criminal offense prior to the adoption of the Istanbul Convention and including clear extraterritoriality clauses. Institutional practice in Norway and Denmark demonstrates, after two decades of application, that the effectiveness of criminal provisions is contingent upon the existence of specialized investigative units and an integrated system of support for victims (Anitha and Gill, 2015).

The hybrid model combines elements of the two aforementioned approaches, incorporating forced marriage as a distinct criminal offense while maintaining a close systematic connection with general provisions on coercion, thereby preserving the coherence of the criminal code's structure. Switzerland provides a paradigmatic example: Article 181a of the Swiss Criminal Code (introduced in 2013) criminalizes forced marriage as a separate offense punishable by up to 5 years' imprisonment, while retaining Article 181 (general coercion) as a subsidiary provision. The extraterritoriality clause is explicit, and the minimum number of years of residence required for the application of the provision has been the subject of significant legislative debate (Swiss Criminal Code, 2013).

Austria adopts a variant of the hybrid model through §106a of the Austrian Criminal Code, which defines forced marriage as an aggravated form of coercion (§105), with an increased penalty ranging from 1 to 5 years' imprisonment. This structure offers the advantage of systematic coherence; however, it also reveals the drawback that the constituent elements are partially dependent on the interpretation of the underlying provision, thereby generating practical uncertainty in its application (Austrian Criminal Code, 2006).

The comparative examination of the constituent elements of the offense across the analysed systems reveals significant differences with regard to the objective element (*actus reus*), the subjective element (*mens rea*), and the sanctioning regime, as summarized in the following table:

Table 1. Comparative analysis of models for the criminalization of forced marriage in selected European states

State	Model	Legal basis	Max. penalty	Extraterritoriality	<i>Actus reus</i> modalities
United Kingdom	Autonomous	ABCPA 2014	7 years	Yes	Coercion, fraud, deception
Germany	Autonomous	§237 StGB	5 years	Partial	Physical/psychological coercion
Belgium	Autonomous	Art. 391sexies	5 years	Yes	Coercion, fraud, abuse of vulnerability
Norway	Autonomous	§253 Straff.	6 years	Yes	Coercion, fraud, transportation
Denmark	Autonomous	§260a Straff.	4 years	Yes	Coercion, transportation
Switzerland	Hybrid	Art. 181a CP	5 years	Yes	Coercion, fraud
Austria	Hybrid	§106a StGB	5 years	Partial	Aggravated coercion
France	Integrated	Art. 222-33-3	3 years	No	General coercion

Source: Prepared by the author based on comparative national legislation and GREVIO reports (2019–2024).

From the perspective of *actus reus*, the Northern European and British autonomous models provide the broadest coverage, encompassing not only physical or psychological coercion, but also deception,

abuse of authority, exploitation of vulnerability, and the cross-border transportation of the victim. This normative expansion corresponds to criminological realities: applied research shows that a significant proportion of forced marriage cases do not involve direct physical violence, but rather subtle forms of family pressure, emotional blackmail, or social isolation (Chantler et al., 2017).

With regard to *mens rea*, all the analyzed systems require direct intent, namely the perpetrator's awareness of the victim's lack of consent and the will to compel them to enter into marriage. Doctrinal debate focuses on the treatment of situations of "*wilful blindness*," in which the perpetrator claims not to have perceived the absence of consent; British and Norwegian legislation have evolved toward an objectified approach, assessing whether a reasonable person would have perceived the lack of consent (Anitha and Gill, 2015).

The sanctioning regime varies between 3 years (France, integrated model) and 7 years (United Kingdom, autonomous model) for the basic form, with significant increases in cases involving minor victims. In its 2019–2024 reports, GREVIO has recommended a minimum threshold of 5 years as an appropriate European standard, emphasizing that the severity of sanctions must be accompanied by effective procedural mechanisms, particularly regarding the protection of witnesses and victims (GREVIO, 2024).

Recent years have witnessed an intensification of debates regarding European harmonization in this field. The Proposal for a Directive of the European Parliament and of the Council on combating violence against women and domestic violence (COM/2022/105), presented by the European Commission in March 2022, initially included provisions relating to forced marriage, which generated discussions concerning the legal basis of the EU's competence in criminal matters. The final Directive, adopted in 2024, retained a common minimum framework on gender-based violence, leaving it to the Member States to define precisely the related offenses, including forced marriage (European Parliament, 2024).

At the level of institutional practice, France announced in 2023 a national action plan on gender-based violence that includes reconsideration of the criminalization of forced marriage, while Italy held parliamentary debates in 2022–2023 regarding the adoption of a model closer to the autonomous approach. These developments indicate a convergent trend toward the autonomous model as an emerging European standard (FRA, 2023).

The effectiveness of any model of criminalization is fundamentally dependent on the quality of procedural-criminal mechanisms and victim protection frameworks. European criminological research consistently shows that, in the absence of specialized support services, victims of forced marriage are often reluctant to file criminal complaints. This reluctance is primarily driven by fears of family retaliation, the potential loss of custody of their children, social exclusion from their communities, and the lack of independent financial resources (Chantler et al., 2017). Consequently, an effective institutional response cannot be limited to the mere existence of a criminal provision; rather, it must incorporate a comprehensive and integrated system for the identification, assistance, and reintegration of victims.

From a procedural-criminal perspective, states that have adopted the autonomous model have developed distinct institutional practices. The United Kingdom, for example, established the Forced Marriage Unit (FMU), an interministerial body (involving the Home Office and the Foreign Office) specialized in handling cases of forced marriage with an international dimension. In 2022 alone, the FMU handled 1,438 calls, of which 24% concerned minor victims (FMU Annual Review, 2022). Similarly, Norway and Denmark have implemented specialized counseling centers for victims, as well as cross-border alert systems that facilitate the rapid exchange of consular information when a victim is detained abroad.

From an evidentiary standpoint, the specific nature of the offense gives rise to particular challenges: the absence of neutral witnesses, the uncertain probative value of marriage documents issued in foreign jurisdictions, and the inherent difficulty of proving the lack of consent before a court. British

practice has evolved toward the acceptance of indirect evidence and the use of cultural expert testimony during trial proceedings, acknowledging that traditional evidentiary standards are often inadequate for offenses committed within closed family environments (Home Office, 2023). In addition, Germany introduced in 2021 the possibility of remote audiovisual testimony for victims in forced marriage proceedings, with the aim of reducing the risk of intimidation in the courtroom. International cooperation represents a crucial dimension in this field, particularly in cross-border cases. The Istanbul Convention (Articles 62–65) imposes obligations on states to cooperate in the investigation and prosecution of covered offenses, including forced marriage. In practice, however, cooperation mechanisms remain insufficient. Differences in the legal definitions of the offense across states create obstacles in the application of the principle of double criminality within extradition procedures and European arrest warrants. This challenge constitutes one of the strongest arguments in favor of further legislative harmonization at the European level (European Parliament, 2024).

Conclusions

The comparative study of models for the criminalization of forced marriage within European criminal law reveals a notable legislative evolution and a clear trend toward convergence on the autonomous model, initially adopted by the Nordic countries and subsequently reinforced by the obligations under the Istanbul Convention. The principal findings of this analysis can be systematically outlined as follows:

First, the autonomous model of criminalization proves to be superior to other models from the perspective of victim protection. Establishing forced marriage as a distinct offense, with its own defined constitutive elements, provides legal clarity, facilitates evidentiary work, and sends a clear normative message to society and potential perpetrators. The experience of the United Kingdom, which has developed the most comprehensive system including complementary civil mechanisms, specialized investigative units, and an extraterritoriality clause serves as a benchmark for other European jurisdictions seeking to enhance the effectiveness of their legal frameworks.

Second, the essential normative components of an effective criminalization model include:

- (a) a consent-based definition encompassing all forms of coercion, whether physical, psychological, fraudulent, or involving abuse of vulnerability;
- (b) criminalization of cross-border transportation of the victim;
- (c) extraterritorial clauses applicable to both citizens and residents;
- (d) aggravating provisions for cases involving minor victims;
- (e) procedural mechanisms ensuring immediate protection of victims;
- (f) complementarity with civil protection instruments to provide a holistic response.

Third, the research highlights the limitations and challenges of current normative frameworks. Systematic underreporting remains a major obstacle, driven by family and cultural pressures, economic dependence of victims, and fear of social stigma. Additionally, unresolved tensions exist between the efficacy of criminal prosecution and the interests of the victim, as criminal proceedings can exacerbate the victim's situation when support mechanisms are insufficient or poorly coordinated. Future research directions could include empirical assessments of the effectiveness of existing criminal provisions through analysis of prosecution and conviction rates comparative examination of institutional practices for identifying and assisting victims, and studies on the feasibility of implementing a harmonized European instrument, particularly in light of ongoing developments in the EU legislative framework on gender-based violence.

This detailed analysis underscores that legal reform alone is insufficient; an effective response requires an integrated system that combines clear criminal definitions, robust procedural safeguards, and complementary civil protections to address the multifaceted realities of forced marriage.

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ONLINE VICTIMIZATION OF MINORS: A CRIMINOLOGICAL ANALYSIS

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Abstract: *This article aims to analyze the phenomenon of the online victimization of minors from a criminological perspective, considering the rapid expansion of digital technologies and their integration into the daily lives of children and adolescents. The study examines the main forms of digital victimization, such as cyberbullying, sexual exploitation, grooming, as well as exposure to harmful content, highlighting the specific characteristics of these manifestations in relation to the offline environment.*

The analytical approach focuses on identifying the criminogenic factors that facilitate the victimization of minors in the virtual space, including anonymity, increased accessibility, lack of effective parental control, and a low level of digital literacy. At the same time, the study considers offender typologies and the mechanisms through which they exploit age-specific vulnerabilities, such as the need for social validation or the lack of experience in risk assessment.

From a theoretical perspective, the analysis is grounded in relevant criminological models, such as routine activity theory, opportunity theory, and social control perspectives, adapted to the digital context. These explanatory frameworks enable a better understanding of the dynamics of online interactions and the ways in which the virtual environment becomes conducive to acts of victimization.

The article also highlights the psychological and social consequences of online victimization on minors, emphasizing both the short-term and long-term impact on their development. Finally, directions for prevention and intervention are outlined, with emphasis on the role of digital education, family, institutions, and the legal framework in reducing risks and protecting minors.

Through its integrated approach, the paper contributes to a better understanding of the phenomenon in the contemporary context and provides useful benchmarks for the development of public policies and effective strategies for preventing crimes targeting minors in the online environment.

Keywords: *online victimization; minors; criminology; cybercrime; cyberbullying; grooming; criminogenic factors; crime prevention; digital environment; juvenile vulnerability*

JEL: K14, K42, D91.

Introduction

The content of the scientific article "*The Phenomenon of the Victimization of Minors in the Online Environment: A Criminological Analysis*" is based on describing the evolution of criminological conceptions regarding the minor who commits an act provided by criminal law, as a starting point for analyzing the extent to which all sources of technology have expanded today. Understanding the meaning of legislative evolution is essential in order to anticipate problems and to reasonably discern which methods or measures can improve the current situation of minors in relation to criminal law. In this context, the accelerated dynamics of the digital environment have led not only to the diversification of forms of criminal activity, but also to the redefinition of the minor's position in relation to it. While traditional approaches focused predominantly on the minor as the perpetrator of a criminal act, there is כיום a significant increase in situations in which the minor becomes a victim, especially in the virtual space.

This paradigm shift requires a reassessment of criminological analytical tools, as the online environment presents distinct particularities compared to the offline one, such as its transnational character, the difficulty of identifying perpetrators, and the rapid spread of harmful effects. Under these conditions, the risks to which minors are exposed take on complex forms that are difficult to

anticipate and control through traditional means. At the same time, interactions in the virtual environment are characterized by a reduction of social barriers and an apparent freedom of expression, aspects that can encourage both deviant behavior and the exploitation of age-specific vulnerabilities. Minors thus become easy targets for criminal strategies adapted to new technologies, which amplifies the need for an in-depth analysis of victimization mechanisms. Against this background, the importance of correlating criminological perspectives with current social realities becomes evident, in order to outline an appropriate explanatory framework. Such an approach allows not only for understanding the phenomenon itself, but also for identifying effective directions for intervention, adapted to the specifics of the digital environment.

Consequently, the proposed analysis focuses on highlighting the relationship between technological evolution and transformations in criminal phenomena, with emphasis on the direct impact on minors. This involves a critical examination of how new forms of criminality influence the structure of victimization, as well as the limitations of current protection mechanisms.

The position of the minor in relation to criminal law has fluctuated alongside their role in society. Over time, minors have been treated in varying ways: sometimes society has fostered their development, while at other times it has treated them with indifference or even brutality.

This evolution reflects profound transformations in social and legal conceptions regarding criminal responsibility and the degree of discernment of minors. From the perception of the minor as a "miniature adult," subject to the same punitive rigor, to the recognition of their psychological and emotional developmental particularities, approaches have gradually become more nuanced, emphasizing protection, education, and social reintegration.

In this regard, modern criminology has significantly contributed to redefining the status of the minor, highlighting the role of social, familial, and environmental factors in the emergence of deviant behavior. Thus, the minor is no longer viewed exclusively through the lens of the committed act, but also as a product of a vulnerable context that may favor both deviance and victimization. This shift in perspective becomes even more relevant in the current context, where the digital environment significantly influences the process of socialization. Online interactions, easy access to information, and exposure to various behavioral patterns contribute to shaping minors' conduct, while also amplifying the risks to which they are subjected.

Therefore, understanding the position of the minor in relation to criminal law can no longer be achieved without analyzing the digital environment, which redefines both the forms of manifestation of criminal behavior and the mechanisms of victimization. This interdependence requires an integrated approach capable of capturing the complexity of the phenomenon in a contemporary context. This historical evolution highlights the complexity of the relationship between the minor and society, as well as the way in which the legal framework has reflected—or, on the contrary, ignored—the specific needs of this vulnerable group. The transition from severe disciplinary punishments to policies oriented toward protection and reintegration has been influenced not only by legislative changes, but also by research in developmental psychology and criminology, which has highlighted the fundamental differences between minors' and adults' capacity for discernment.

At the same time, technological development and the expansion of the digital environment have created new contexts in which minors interact, communicate, and socially develop, generating both opportunities and unprecedented risks. Phenomena such as cyberbullying, grooming, or access to harmful content have radically changed the way minors can be affected by criminality, emphasizing the need for a criminological approach that integrates both traditional aspects of victimization and the new particularities of the virtual environment.

Moreover, the contemporary minor occupies a dual position: on the one hand, they may act as an agent of deviant behavior, and on the other hand, they become a potential victim of sophisticated criminal acts facilitated by technology. This duality highlights the importance of an integrated analysis that connects classical criminological theories with current digital realities and allows for the

identification of criminogenic factors, vulnerabilities, and protection mechanisms adapted to new conditions. Therefore, this article aims to explore these complex interactions, highlighting how the evolution of the legal and social framework intersects with technological development, in order to provide a clear picture of the phenomenon of minor victimization in the online environment and possible directions for prevention and intervention.

The Minor and Social Responsibility

The Concept of the Minor in the Past and Present

The term "minor" essentially refers to a person below the age at which the law recognizes full capacity to exercise civil and criminal rights and obligations. Throughout history, this notion has evolved significantly, influenced by cultural, religious, and legal norms. In medieval and premodern periods, the minor was often seen as a "miniature adult," responsible for their actions almost to the same extent as adults, yet lacking the necessary means and protection. In many societies, even very young children could be subjected to criminal punishment or forced labor; for example, within feudal systems, minors were involved in hard labor or armed conflicts under the authority of the family or ruler.

With the development of the modern concept of law and the emergence of studies in psychology and pedagogy, the perception of the minor changed, emphasizing their vulnerability and need for protection. Today, the minor is recognized as an individual with special rights, requiring support for physical, emotional, and social development. Contemporary criminal law reflects this shift by adapting criminal liability according to the minor's age and discernment, as well as by establishing alternative measures focused on education and reintegration.

The Minor's Responsibility in Society: Historical Evolution

The social responsibility of minors has also been subject to fluctuation. In traditional societies, children were directly integrated into economic and family structures, holding important functional roles such as working in the household, agriculture, or family trades. In this context, their responsibility was more practical than legal, and compliance with community rules was strictly monitored by the family and local authorities.

For example, in medieval Europe, children from artisan families learned trades from an early age, and their mistakes could lead to punishments or social sanctions, reflecting both their role in the family economy and the strict norms of the community.

As society evolved, the responsibility of minors became more nuanced: the emphasis shifted from punishment to education, from economic roles to social and moral development. Schools and social institutions began to promote the formation of responsible citizens, prepared to respect norms and collective values, without being exposed to severe sanctions before understanding the consequences of their actions.

The Minor's Responsibility in Contemporary Society

Today, the responsibility of minors is based on a balance between autonomy and protection. Minors have both rights and obligations, but the social, educational, and legal framework aims at the gradual development of their sense of responsibility. In the contemporary environment, responsibility is no longer limited to family or the local community, but also includes the digital environment, where minors frequently interact.

Recent examples include minors' participation in online communities, adherence to rules of digital behavior, and awareness of risks such as cyberbullying, grooming, or the distribution of inappropriate content. At the same time, minors may become vulnerable, which highlights the need for digital education mechanisms and balanced supervision.

Thus, the evolution of minors' responsibility reflects the transition from roles imposed by society and family to a progressively assumed responsibility, depending on individual development and the contemporary social and technological context.

The Link Between the Minor's Social Responsibility and Victimization in the Online Environment

The evolution of the minor's role in society has direct implications for how they are exposed to risks in the digital environment. As minors gain autonomy and actively participate in social and online life, their responsibility extends not only to their own actions but also to managing the risks associated with virtual interactions. Lack of experience, the desire for acceptance in online groups, or misunderstanding the limits of digital interactions can transform the minor from an active agent into a potential victim of cybercrime.

In contemporary society, the online environment represents a space for socialization and expression, but also a context in which minors' vulnerabilities can be exploited by offenders through methods such as grooming, cyberbullying, or exposure to harmful content. The social responsibility of minors is therefore not limited to respecting traditional societal rules, but also includes developing digital safety skills and the ability to recognize risky situations.

Therefore, the analysis of the phenomenon of minor victimization in the online environment cannot be separated from understanding their social role. Understanding the evolution of responsibility and the minor's position provides an essential framework for identifying criminogenic factors, age-specific vulnerabilities, and ways in which educational, familial, and legal interventions can be optimized to protect minors in the digital age.

Criminogenic Factors and Vulnerabilities of Minors in the Online Environment

The Virtual Environment as a Space of Risk

The expansion of access to technology and the integration of the online environment into minors' daily lives have created a context in which exposure to risks is significantly increased. The digital environment offers anonymity, rapid communication, and unlimited access to various types of content—elements which, if not properly managed, can facilitate situations of victimization. This characteristic makes minors more vulnerable to criminal acts than in offline spaces, and the risks are not only individual but also collective, affecting entire online communities.

Main Criminogenic Factors

Criminological analysis identifies several factors that contribute to the victimization of minors in the online environment. On the one hand, anonymity facilitates actions such as grooming or online harassment, giving offenders a strategic advantage. On the other hand, increased accessibility and the borderless freedom of social media platforms mean that minors spend significant amounts of time on these networks, often identifying with them. Additionally, a low level of digital education plays a crucial role: minors who are unfamiliar with online safety rules or unable to recognize risky situations are more prone to exploitation.

Age-Specific Vulnerabilities -In today's digital world, minors grow up in an environment where social interactions are no longer limited to school, family, or close friends, but extend into a vast virtual space where boundaries are often unclear. This reality brings numerous opportunities, but also risks, especially due to age-specific vulnerabilities. These vulnerabilities do not arise randomly; they are closely linked to the stage of cognitive and emotional development in which minors find themselves.

One of the most important aspects is the strong need for social validation and acceptance. During adolescence, personal identity is still forming, and the opinions of others become highly significant. In the online environment, this need translates into the desire to receive likes, positive comments, or as many followers as possible. For a minor, these reactions can become a measure of self-worth. As a result, there is a temptation to post personal information, photos, or intimate details without fully understanding the consequences. In some cases, minors may accept friend requests or messages from strangers simply to increase their popularity or to avoid feeling "invisible" online. This need for validation can be exploited by ill-intentioned individuals who use compliments or attention to gain minors' trust. In addition, another important factor is the lack of experience in risk assessment. The

ability to anticipate the consequences of an action is not fully developed in minors, as it depends on the maturation of complex cognitive processes. Decisions are often made impulsively, under the influence of emotions or curiosity. For example, a minor may consider sending a personal photo to someone met online as harmless, without thinking about the possibility that the image could be shared further or used abusively. At the same time, lack of experience makes minors more vulnerable to manipulation. They cannot always distinguish between genuine and hidden intentions, especially when communication takes place through written messages, where cues such as tone of voice or facial expressions are absent.

This difficulty in assessing risks is amplified by the fact that the online environment creates a false sense of safety. Interactions occur through screens, and physical distance can give the impression that dangers are not real or immediate. Minors may believe they can control situations more easily than in real life, leading them to take greater risks. Moreover, the fact that many platforms are designed to be attractive and easy to use contributes to reduced vigilance.

Another essential element is the influence of peer groups and social pressure. During adolescence, belonging to a group is extremely important, and the fear of exclusion can lead to risky behaviors. In the online environment, these pressures can take various forms, from participating in dangerous challenges to sharing inappropriate content. Often, minors do not act out of personal desire, but to conform to group expectations. If most friends post certain types of content or interact with strangers, there is a tendency to do the same to avoid being left out. Social pressure can be subtle but very powerful. Comments, reactions, or even their absence can influence minors' behavior. For example, a teenager may continue communicating with a suspicious person simply because their friends consider it "cool" or interesting. In other situations, minors may ignore warning signs—such as persistent requests for personal information or inappropriate behavior—because they do not want to appear naive or overly cautious in front of others.

All these vulnerabilities are interconnected and can reinforce one another. The need for validation may lead to risky interactions, lack of experience makes it difficult to recognize danger, and peer pressure pushes minors to continue such behaviors. In addition, the online environment evolves rapidly, and new trends or platforms may introduce additional risks that minors are not prepared to manage.

It is important to understand that these vulnerabilities are not individual weaknesses, but normal characteristics of development. For this reason, solutions should not rely on rigid restrictions, but on education and support. Minors need to learn how to protect their personal information, how to recognize suspicious behavior, and how to make informed decisions online. At the same time, open dialogue with adults—whether parents, teachers, or counselors—is essential, so that minors feel safe asking for help when facing difficult situations.

In conclusion, age-specific vulnerabilities of minors in the online environment result from a combination of psychological and social factors. The need for acceptance, lack of experience, and peer pressure contribute to their exposure to significant risks. Understanding these aspects is essential for developing effective prevention and protection strategies adapted to the digital reality.

Typologies of Online Offenders and Mechanisms of Exploitation

In a world where the internet has become part of everyday life, children and adolescents spend increasing amounts of time online, whether for school, entertainment, or staying connected with friends. Often, this space appears friendly and safe, yet behind screens there may be individuals who use the internet to cause harm. These individuals do not look like "criminals" in the traditional sense; they have no visible signs and cannot be easily recognized. That is why it is important to understand who they are, how they act, and especially how they manage to gain minors' trust.

Let us imagine a typical teenager who creates a social media account, posts photos, talks to classmates, and at some point receives a message from a stranger. The person seems friendly, claims

to share the same interests, and starts a normal conversation. At first, everything appears harmless. This is often the first step through which a certain type of online offender tries to enter a minor's life. One important category is that of online sexual predators. They never begin directly with their real intentions. On the contrary, they build an image of a trustworthy person. They may pretend to be the same age as the victim or even a close friend. They speak kindly, offer compliments, and try to create an emotional connection. This process is known as "gaining trust." Over time, conversations become increasingly personal. The minor may feel they have found someone who truly understands them, especially if they feel lonely or misunderstood in real life. Once this bond is established, the predator begins to request more intimate things, such as personal photos, private information, or inappropriate conversations. Everything happens gradually, so the minor does not realize when the interaction shifts from normal to dangerous. In some cases, if the minor refuses, the offender may become manipulative or threatening, claiming they will expose already received information. This leads to blackmail, leaving the child feeling trapped and frightened.

Another type of offender includes online harassers and aggressors. These individuals are not necessarily interested in building trust, but rather in exercising power over others. Often, they are people who know the victim in real life, such as classmates, though they may also be strangers. Online harassment can take many forms: insulting messages, spreading rumors, posting embarrassing photos, or deliberately excluding someone from online groups. For instance, a child may post a photo and receive hurtful comments instead of appreciation. At first, it may seem like a joke, but when repeated daily, the impact becomes severe. The child may feel ashamed, sad, or even scared. In some cases, aggressors escalate to threats or blackmail, forcing the victim to comply with certain demands to stop the harassment. The problem is that online abuse can continue constantly, leaving the victim with no safe space.

There is also a less obvious but equally dangerous category: economic or information exploiters. These individuals are not necessarily interested in personal relationships, but in what they can obtain from victims. They may send messages that appear to be offers, contests, or games, requesting personal data such as name, address, passwords, or family information. For a child, such requests may seem harmless, especially if presented as a game or an opportunity to win something. For example, a message might say: "You've won a prize! Enter your details to claim it." Without experience, a minor may believe it and provide important information. This data can then be used for fraud, account access, or other illegal activities. Sometimes, offenders use more sophisticated techniques, such as creating websites that closely resemble official ones to deceive users.

All these types of offenders share a common element: they rely on psychological manipulation rather than physical force. They understand how children think and feel. For example, they know minors seek friendship and acceptance, so they offer exactly that at the beginning. They know minors can be curious or impulsive, so they create situations that seem exciting or urgent. In many cases, they also create a sense of secrecy, saying things like "don't tell anyone about our conversation," which isolates the victim and makes them easier to control.

Another important mechanism is emotional exploitation. Offenders may use empathy, telling sad stories to gain sympathy, or fear, threatening serious consequences. Sometimes they alternate between positive and negative behavior, creating confusion and emotional dependence. The minor becomes unsure how to react and remains trapped in the relationship.

The digital environment provides offenders with a major advantage: anonymity. They can create fake accounts, use stolen photos, and pretend to be someone else. They can also communicate with multiple victims simultaneously and adapt quickly if one method fails.

For children, all these aspects can be difficult to understand, especially because the danger is not visible. There is no clear signal indicating that someone is dangerous. Therefore, education and awareness are essential. Children must learn that not every friendly person is trustworthy and that personal information must be protected. It is equally important for minors to know they are not alone

and can seek help. If something feels strange or uncomfortable, it is a sign to talk to a trusted adult. They should not fear consequences or believe it is their fault—the responsibility lies with the offender. At the same time, minors should learn some simple rules: do not accept friend requests from strangers, do not send personal photos, do not share passwords or sensitive data, and verify information before trusting it. They should also pay attention to warning signs such as persistent requests, pressure-inducing messages, or promises that seem too good to be true.

In conclusion, the online world is neither completely safe nor entirely dangerous. It is a space that must be used carefully and responsibly. Online offenders exist and use increasingly sophisticated methods, but with the right knowledge and support, children can learn to protect themselves. Understanding these typologies and mechanisms is the first step toward safety.

Implications for Societal Support in the Criminological Context

After analyzing age-specific vulnerabilities and the typologies of online offenders, it becomes increasingly clear that the issue of minors' safety in the digital environment is neither simple nor solvable solely through children's individual responsibility. In fact, society as a whole plays an essential role in preventing and combating these risks. Criminological analysis does not only explain why certain behaviors or crimes occur, but also provides a foundation for developing real, context-adapted solutions.

First, it is important to recognize that minors cannot be considered fully responsible for their decisions in the online environment. As discussed, they are in a developmental stage where the ability to assess risks, anticipate consequences, and resist social pressure is not fully formed. For this reason, criminological analysis emphasizes the context in which these vulnerabilities arise—not only the child's behavior, but the interaction between the child, the digital environment, and surrounding social influences.

Society has the responsibility to create a safer environment for minors, starting with education. It is not enough for students to learn how to use technology; they must also learn how to use it safely. Digital education should include clear explanations about online risks, how offenders operate, and practical steps children can take to protect themselves. These concepts must be presented in an accessible and relatable manner.

In addition to schools, the family plays a crucial role. Parents do not need to be technology experts, but they must be involved and attentive. Open communication is key. A child who feels safe discussing online experiences is more likely to seek help when facing difficulties. Conversely, fear of punishment or misunderstanding may lead the child to hide problems, increasing vulnerability.

Another key aspect highlighted by criminological analysis is the need for effective public policies. State institutions must keep pace with technological developments and create strategies that address new forms of online crime. This includes clear laws, accessible reporting mechanisms, and rapid intervention in abuse cases. Cooperation between authorities and digital platforms is also essential to reduce harmful content and identify offenders more effectively.

Online platforms themselves bear significant responsibility. They are not neutral spaces, but environments that influence user behavior. Through their design, they can promote either safety or risk. Privacy settings, reporting systems, and content moderation are essential tools for protecting minors. Platforms that offer clear and user-friendly tools for blocking or reporting abuse directly contribute to risk reduction. The community also plays an important role. Teachers, school counselors, NGOs, and even peers can significantly support minors. Sometimes, a child may not turn to parents or authorities but may confide in a teacher or friend. Therefore, all individuals involved in minors' lives should be informed and prepared to recognize warning signs, such as behavioral changes, social withdrawal, anxiety, or reluctance to use certain devices.

Conclusions

Criminological analysis shows that prevention is far more effective than intervention after harm has already occurred. Once a minor becomes a victim, the consequences—especially emotional ones—can be difficult to repair. Therefore, emphasis must be placed on preventive mechanisms that reduce the likelihood of such situations. These include awareness, critical thinking development, and encouraging responsible online behavior.

An essential aspect is fostering minors' sense of responsibility in a balanced way. It is not fair to expect them to manage all risks alone, but it is important to teach them to make better decisions. For example, asking themselves simple questions before acting: "Do I know this person?", "Is it safe to share this information?", "What could happen if this message is shared further?" Such reflections can make a significant difference.

At the same time, it is important to avoid scaring children or portraying the internet as entirely dangerous. This approach may lead either to rejection of the message or unnecessary anxiety. A balanced perspective is more effective, helping children understand both the benefits and risks of the online environment.

Overall, protecting minors is the result of collaboration among multiple actors: the child, family, school, community, state institutions, and digital platforms. No single factor can solve the problem alone. Only through an integrated approach can real results be achieved.

In conclusion, criminological analysis not only explains the phenomenon of online victimization but also provides clear directions for action. Understanding minors' vulnerabilities and offenders' methods allows for the development of more effective prevention strategies. Society has the responsibility to create a safe environment in which children are informed, supported, and protected. Through education, communication, appropriate policies, and active involvement, risks can be significantly reduced. Thus, the online environment can become not only a space for interaction, but also one in which minors can develop safely, confident that they are not alone and that support is always available when needed.

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ARTIFICIAL INTELLIGENCE IN CRIMINAL JUSTICE: LEGAL CHALLENGES TO FAIR TRIAL GUARANTEES AND PROCEDURAL SAFEGUARDS

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Abstract: *The increasing use of artificial intelligence in criminal justice is no longer a distant prospect but an emerging reality that is gradually reshaping procedural practices. Algorithmic tools are increasingly involved in risk assessment, data analysis, and evidentiary evaluation, particularly in cases involving complex digital environments. The main aim of this study is to examine the legal implications of integrating artificial intelligence into criminal proceedings, with a particular focus on its impact on fair trial guarantees and procedural safeguards. The analysis draws on international human rights standards, selected jurisprudence of the European Court of Human Rights, and recent developments in European Union regulatory approaches to artificial intelligence. The research is based on a doctrinal and comparative legal methodology, allowing for an assessment of how existing legal frameworks respond to the challenges posed by algorithmic decision-making. Particular attention is given to issues of transparency, contestability, and the ability of parties to effectively challenge AI-generated outcomes. The findings indicate that the opacity of algorithmic systems creates significant difficulties for maintaining equality of arms, particularly in situations where procedural rules do not adequately ensure meaningful access to the reasoning underlying automated outputs. It is argued that without clearly defined safeguards ensuring transparency, accountability, and proportionality, the use of artificial intelligence risks undermining the fairness and legitimacy of criminal proceedings.*

Key words: *artificial intelligence, criminal justice, fair trial, procedural safeguards, legal accountability.*

JEL: K14, K40, O33.

Introduction

Over the past decade, the use of artificial intelligence within criminal justice systems has moved beyond theoretical discussion and entered practical application. Law enforcement authorities and judicial actors increasingly rely on algorithmic tools to process large datasets, identify patterns, and support decision-making. This development is often framed as a response to the growing complexity of digital environments, where traditional procedural mechanisms struggle to manage the scale and speed of information flows.

At first glance, such technologies appear to enhance efficiency and objectivity. Yet their integration into criminal proceedings does more than accelerate existing processes. It gradually reshapes how decisions are formed and justified. Elements that were once grounded in human reasoning are now influenced by systems whose internal logic cannot always be fully accessed or explained within the courtroom. In this sense, the issue is not limited to technical reliability but extends to the conditions under which legal judgments are produced.

A central difficulty arises from the tension between algorithmic opacity and the requirements of procedural transparency. Criminal procedure has long been built on the assumption that evidence can be examined, challenged, and interpreted by all parties involved. Where algorithmic tools are used to generate or evaluate information, this assumption becomes less stable. The reasoning underlying automated outputs may not be meaningfully accessible, which can affect the ability of the defense to contest such material and, consequently, disturb the balance between the parties.

These concerns are not merely theoretical. Empirical and doctrinal discussions on algorithmic decision-making have shown that such systems may reproduce patterns embedded in historical data, including forms of structural bias (Angwin et al., 2016). At the same time, European human rights law consistently emphasizes that any interference with individual rights must satisfy the requirements of foreseeability, proportionality, and effective judicial control, as reflected in the jurisprudence of the European Court of Human Rights (Klass and Others v. Germany, 1978; Roman Zakharov v. Russia, 2015).

From a doctrinal perspective, this creates a structural tension between efficiency-oriented technological development and the normative foundations of criminal justice. Judicial decision-making is not merely a technical exercise, but a process grounded in legal reasoning, accountability, and the obligation to provide reasons that can be scrutinized by the parties and, where necessary, by higher courts. As noted in the literature, the increasing reliance on automated systems challenges the traditional understanding of judicial responsibility and the transparency of adjudication (Mitsilegas, 2022).

In this context, it becomes increasingly difficult to treat artificial intelligence as simply another technical instrument. The more complex question concerns whether existing legal frameworks are capable of accommodating such technologies without weakening core procedural guarantees. This includes not only the right to a fair trial, but also broader principles such as equality of arms, legal certainty, and the integrity of judicial reasoning.

The analysis that follows adopts a doctrinal and comparative legal perspective. Rather than focusing on the technical architecture of artificial intelligence systems, it examines their legal implications within criminal proceedings. Particular attention is given to the relationship between algorithmic decision-making and fundamental procedural safeguards, especially in light of evolving European legal standards and the emerging regulatory framework on artificial intelligence.

Basic content

The use of artificial intelligence in criminal justice.

The integration of artificial intelligence into criminal justice has not occurred through a single coordinated reform, but rather through the gradual introduction of tools addressing specific practical needs. Today, algorithmic systems are used at various stages of criminal proceedings, including policing, pre-trial decision-making, and the handling of evidence. Although these systems do not operate independently of legal actors, they increasingly shape the informational environment within which decisions are formed.

In the context of policing, predictive models are used to identify spatial and temporal patterns of crime and to support the allocation of resources. Systems such as PredPol rely on historical crime data to generate forecasts about potential future incidents. While these models are often presented as neutral and data-driven, their outputs remain closely tied to the structure of the underlying data. Where past enforcement practices have reflected existing social inequalities, predictive systems may reproduce these patterns rather than correct them (Ferguson, 2017). As a result, algorithmic predictions may reinforce pre-existing forms of selective attention within policing strategies (Angwin et al., 2016).

A similar set of issues arises in the use of risk assessment tools within judicial decision-making. Instruments such as COMPAS are designed to estimate the likelihood of reoffending and are used in decisions related to bail, sentencing, and parole. Although these tools are intended to improve consistency and reduce subjective bias, empirical studies have shown that their predictive performance is contested and, in certain contexts, does not significantly exceed that of human judgment (Dressel & Farid, 2018). More importantly, the variables on which such systems rely may indirectly reflect socio-economic conditions, leading to outcomes that are difficult to reconcile with the principle of equal treatment before the law.

Artificial intelligence also plays an increasingly significant role in the handling of digital evidence. In investigations involving large volumes of electronic data, algorithmic systems are used to filter,

classify, and prioritize information. This allows investigators to process material at a scale that would otherwise be impractical. At the same time, this development alters the evidentiary landscape. The interpretation of information becomes partially dependent on automated processes, raising questions about how such outputs should be assessed within established legal standards and how their reliability can be effectively scrutinized in court.

What unites these different applications is not their technical design, but their influence on the structure of decision-making. Algorithmic systems do not merely provide additional information; they affect which information is considered relevant and how it is organized. This, in turn, shapes the reasoning process itself. Where decision-makers rely on system-generated outputs without full insight into the processes behind them, the relationship between human judgment and technological input becomes increasingly difficult to define (Mitsilegas, 2022).

From a legal perspective, this shift raises concerns that extend beyond questions of efficiency. The use of artificial intelligence affects the evidentiary basis of proceedings, the distribution of informational power between the parties, and the capacity of courts to exercise independent evaluation. In particular, the limited transparency of many AI systems, often described as the "black box" problem, complicates the ability of the defense to effectively challenge the material relied upon by the prosecution. This challenge is increasingly recognized within the European regulatory framework, where AI systems used in criminal justice are classified as high-risk under the EU Artificial Intelligence Act (Regulation (EU) 2024/1689). Where access to the reasoning underlying algorithmic outputs remains restricted, procedural guarantees, including the right to a fair trial under Article 6 of the European Convention on Human Rights, risk becoming formal rather than substantive (Zalnieriute, 2026).

In this sense, the use of artificial intelligence in criminal justice reflects a broader transformation in the conditions under which legal decisions are produced. While these technologies expand institutional capacity, they also introduce new forms of dependency that are not easily accommodated within existing procedural frameworks. Understanding their role therefore requires not only a technical description of their functions, but a legal assessment of their implications for fairness, accountability, and the overall structure of criminal proceedings.

Table 1. Key Applications of AI in Criminal Justice and Associated Legal Concerns

Application Area	Primary Function	Core Legal and Procedural Risks
Predictive policing	Identifying crime-prone areas and temporal patterns based on historical data.	Reproduction of structural biases; risk of circular reasoning in policing strategies.
Risk assessment	Estimating the likelihood of recidivism to support judicial decisions.	Challenges to the principle of equal treatment; opacity in algorithmic scoring (e.g., COMPAS).
Digital evidence handling	Filtering, classifying, and prioritizing massive datasets (e-discovery).	Reliability concerns; difficulties in establishing an accessible chain of evidentiary reasoning.
Decision-support systems	Assisting prosecutors and judges in complex legal evaluations.	"Automation bias"; shifting the balance between human judgment and algorithmic input.

Source: Author's compilation based on Ferguson (2017), Angwin et al. (2016), Dressel & Farid (2018), and Mitsilegas (2022).

Legal challenges of algorithmic decision-making

While the use of artificial intelligence in criminal justice is often justified in terms of efficiency and consistency, its integration raises a set of legal challenges that cannot be addressed within traditional procedural frameworks. These challenges do not arise solely from the technical complexity of algorithmic systems, but from the mismatch between their operational logic and the normative structure of criminal procedure (Hildebrandt, 2016).

One of the most persistent difficulties concerns the issue of transparency. Many algorithmic systems used in criminal justice operate through complex computational models that are not readily interpretable by non-specialists. This lack of interpretability becomes legally significant when such systems influence decisions affecting individual rights. Unlike traditional forms of evidence, which can be examined and contested through established procedural mechanisms, algorithmic outputs often lack a clear and accessible chain of reasoning (Pasquale, 2015). As a result, it becomes difficult to determine on what basis a particular conclusion has been reached.

Closely related to this is the problem of explainability. In legal proceedings, the ability to provide reasons for a decision is not merely a formal requirement, but a substantive safeguard that allows parties to understand and challenge the outcome. Where algorithmic systems are involved, this requirement is not always easily satisfied. Even when some level of explanation is provided, it may not be sufficient to allow meaningful scrutiny within an adversarial process (Selbst and Baracos, 2018). This creates a situation in which the formal existence of procedural rights does not necessarily translate into their effective exercise.

These concerns directly affect the principle of equality of arms. Criminal proceedings are structured around the idea that both parties should have a fair opportunity to present their case under conditions that do not place one side at a substantial disadvantage. Where one party—typically the prosecution—relies on algorithmic tools whose functioning is not fully disclosed or understood, this balance may be disrupted. The defense may be placed in a position where it is required to challenge conclusions without access to the underlying reasoning, which undermines the effectiveness of adversarial argument (Zalnieriute, 2026).

Another important dimension of the problem relates to accountability. In traditional legal frameworks, responsibility for decisions can be attributed to identifiable actors, such as investigators, prosecutors, or judges. The introduction of algorithmic systems complicates this model. Where decisions are influenced by automated tools, it becomes less clear who bears responsibility for potential errors or biases. This diffusion of responsibility raises concerns not only at the level of individual cases, but also in relation to systemic oversight (Binns, 2018).

These issues are increasingly reflected in European legal developments. The EU Artificial Intelligence Act explicitly classifies AI systems used in criminal justice as high-risk, recognizing their potential impact on fundamental rights. However, the regulatory approach remains primarily *ex ante*, focusing on risk management and compliance requirements, rather than on the procedural implications within individual cases. This creates a gap between regulatory design and procedural reality, where formal safeguards may not fully address the challenges that arise in practice.

From the perspective of human rights law, the central concern is whether existing legal guarantees remain effective in the context of algorithmic decision-making. The jurisprudence of the European Court of Human Rights has consistently emphasized that rights such as the right to a fair trial must be practical and effective, rather than theoretical or illusory. Applying this standard to cases involving artificial intelligence suggests that the mere formal availability of procedural rights is insufficient where the conditions necessary for their meaningful exercise are not met.

In this sense, the legal challenges posed by artificial intelligence are not isolated or technical in nature. They reflect a deeper tension between emerging forms of decision-making and the principles on which criminal procedure is based. Addressing this tension requires more than incremental

adjustments; it calls for a reconsideration of how transparency, accountability, and fairness are ensured in a context where the sources of decision-making are no longer fully visible.

Fair trial guarantees and procedural safeguards

The challenges associated with the use of artificial intelligence in criminal proceedings become particularly visible when assessed through the lens of fair trial guarantees. Unlike broader regulatory concerns, these guarantees are not abstract principles but operational standards that determine whether a proceeding can be considered legally legitimate. The integration of algorithmic tools therefore requires an evaluation not only of their functionality, but of their compatibility with the core requirements of procedural justice.

At the center of this assessment lies the right to a fair trial, as enshrined in Article 6 of the European Convention on Human Rights. The jurisprudence of the European Court of Human Rights has consistently emphasized that this right must be "practical and effective" rather than merely formal (*Artico v. Italy*, 1980). In cases involving complex or opaque forms of evidence, the Court has stressed the importance of ensuring that the accused is able to understand, challenge, and respond to the material used against them. This requirement becomes significantly more difficult to satisfy where decision-making is influenced by algorithmic systems whose internal logic is not fully accessible. Recent scholarship suggests that the growing reliance on automated processes in adjudication raises broader questions about the continued effectiveness of traditional procedural safeguards (Fikfak and Helfer, 2024). In such contexts, there is a risk that the formal availability of rights does not translate into their effective exercise, particularly where the reasoning underlying a decision cannot be meaningfully examined.

One of the most affected guarantees is the principle of equality of arms. This principle requires that each party be given a reasonable opportunity to present its case under conditions that do not place it at a substantial disadvantage vis-à-vis the opponent (*Dombo Beheer B.V. v. Netherlands*, 1993). Where the prosecution relies on AI-assisted tools, particularly in the analysis of evidence or risk assessment, the defense may face structural limitations in accessing or interpreting the underlying reasoning. Even where disclosure obligations are formally respected, the technical nature of algorithmic outputs may prevent meaningful contestation, thereby weakening the adversarial balance (Zalnieriute, 2026).

Closely linked to this is the right to an effective defense. The ability to challenge evidence presupposes not only access to information, but also the capacity to understand and scrutinize it. In the context of AI-generated outputs, this presupposition is not always met. Where the reasoning process of a system cannot be reconstructed or explained in a comprehensible manner, the defense is placed in a position where it must contest conclusions without being able to engage with their basis. This risks transforming procedural rights into formal guarantees lacking substantive content (Hildebrandt, 2016).

The requirement of judicial impartiality is also affected, albeit in a more subtle way. Judges are expected to base their decisions on evidence that can be evaluated independently and transparently. Where algorithmic tools are used to organize or interpret information, there is a risk that judicial reasoning becomes indirectly shaped by processes that are not fully subject to scrutiny (Parasuraman & Manzey, 2010). This does not necessarily imply bias in the traditional sense, but it may affect the independence of judgment by introducing elements that cannot be fully assessed within the legal framework.

These concerns must also be understood in light of the broader doctrine of the "quality of law," as developed in the case law of the European Court of Human Rights. According to this doctrine, legal rules that interfere with individual rights must be accessible, precise, and foreseeable in their application (*Klass and Others v. Germany*, 1978; *Sunday Times v. UK*, 1979). The use of artificial intelligence complicates this requirement, particularly where the operation of algorithmic systems is

not transparent or where their outcomes are not sufficiently predictable. In such situations, the individual may be affected by decisions whose underlying logic cannot be reasonably anticipated. In this context, the central issue is not whether artificial intelligence can be used in criminal justice, but under what conditions its use remains compatible with fundamental procedural guarantees. The analysis suggests that the existing framework of fair trial rights is not inherently incompatible with technological development. However, its effectiveness depends on the extent to which procedural safeguards are adapted to address the specific risks associated with algorithmic decision-making.

Ultimately, ensuring compliance with fair trial guarantees in the age of artificial intelligence requires more than the formal recognition of rights. It demands the creation of procedural mechanisms capable of translating these rights into practical protections. This includes, in particular, ensuring meaningful access to the reasoning underlying automated outputs, strengthening the capacity of the defense to challenge such material, and preserving the role of the judge as an independent and fully informed decision-maker (Mitsilegas, 2022).

Legal responsibility and accountability

The increasing reliance on artificial intelligence in criminal justice raises a question that is less visible than issues of fairness or transparency, yet equally fundamental: who bears responsibility when algorithmic systems influence legal outcomes. Unlike traditional decision-making structures, where responsibility can be traced to identifiable actors, the use of AI introduces a more fragmented and diffuse model of accountability, a situation that closely resembles what has been described in legal and political theory as the "problem of many hands" (Thompson, 1980; Nissenbaum, 1996).

In conventional procedural frameworks, legal responsibility is attached to human decision-makers. Investigators, prosecutors, and judges are expected to justify their actions and can be held accountable for errors or violations of rights. The introduction of algorithmic systems complicates this model without fully replacing it. Decisions are rarely made by AI alone; rather, they are shaped through an interaction between human judgment and system-generated outputs. This hybrid structure makes it more difficult to determine whether responsibility lies with the individual relying on the system, the institution deploying it, or the entity responsible for its design (Binns, 2018).

This difficulty becomes particularly apparent in cases where algorithmic outputs prove to be inaccurate, biased, or misleading. If a decision is influenced by a system whose internal logic is not fully understood, attributing fault becomes problematic. Human actors may argue that they relied on a tool presented as reliable, while developers may claim that the system was used outside its intended context (Parasuraman & Manzey, 2010). As a result, responsibility risks being diffused across multiple actors, without any single point of clear accountability.

From a legal perspective, this situation challenges the traditional foundations of responsibility. Criminal procedure is built on the assumption that decisions can be traced back to accountable actors whose reasoning can be examined and, where necessary, contested. Where algorithmic systems intervene in this process, this assumption becomes less certain. The difficulty is not only in identifying responsibility after an error has occurred, but in ensuring that responsibility is structured in a way that prevents such errors in the first place.

European regulatory developments reflect an increasing awareness of these concerns, yet they do not fully resolve them. The EU Artificial Intelligence Act (Regulation (EU) 2024/1689) introduces a set of obligations for both developers and users of high-risk systems, including requirements for human oversight (Article 14). While these measures are designed to mitigate risks at the design and deployment stages, their focus remains largely preventive and compliance-oriented.

In practice, this regulatory approach does not easily translate into clear procedural standards for attributing responsibility within individual criminal cases, particularly where algorithmic outputs are relied upon in evidentiary reasoning. The result is a persistent gap between administrative compliance and the requirements of criminal liability or procedural accountability, a tension increasingly noted in the literature (Koops, 2021).

In this context, the challenge is not to replace human responsibility with technological accountability, but to preserve the primacy of human decision-making while ensuring that the use of AI does not obscure the lines of responsibility. This requires a legal approach in which algorithmic tools remain subject to meaningful oversight, and where the actors relying on such tools retain full responsibility for the decisions they influence.

Ultimately, the question of accountability highlights a broader concern: the risk that technological complexity may weaken the link between decision-making and responsibility. Preventing this outcome is essential for maintaining not only procedural fairness, but also the legitimacy of criminal justice systems as a whole.

Conclusions

The increasing integration of artificial intelligence into criminal justice systems reveals a growing tension between technological efficiency and procedural fairness. While AI systems expand the capacity of institutions to navigate complex digital environments, they also affect the conditions under which legal decisions are formed and justified.

The analysis shows that the main legal challenges arise from algorithmic opacity, the difficulty of effectively contesting automated outputs, and the diffusion of responsibility within hybrid decision-making structures. These factors directly affect the practical effectiveness of fair trial guarantees under Article 6 of the ECHR, in particular the principle of equality of arms and the right to an effective defense.

Although the EU Artificial Intelligence Act (2024) and related regulatory initiatives acknowledge these risks, a gap remains between ex ante risk management and the procedural protection of individual rights in concrete cases. Consequently, ensuring meaningful transparency, preserving judicial autonomy, and maintaining clear lines of accountability should not be seen as technical adjustments, but as necessary conditions for sustaining the legitimacy and integrity of criminal justice systems in a technologically mediated environment.

At the same time, the present analysis is subject to certain limitations. It is primarily based on doctrinal and comparative legal methods and does not include empirical assessment of how AI systems function in practice. Future research could further explore the practical implementation of procedural safeguards in real cases, as well as the interaction between technological design and legal standards, in order to develop more effective models for integrating artificial intelligence into criminal justice.

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ARTIFICIAL INTELLIGENCE - RISK OR SECURITY IN FORENSICS?

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Abstract: *Artificial intelligence influences the areas of our lives, including forensic investigations. The accelerated development of cutting-edge technologies has brought a series of advantages but also vulnerabilities and risks.*

Excessive dependence affects several aspects of the criminal process.

The paper analyzes the duality of artificial intelligence in the forensic process, highlighting both its role as a security and efficiency tool for investigations, as well as its potential for risk in the context of cybercrime and ethical and legal challenges, aiming to identify a balance between the advantages of technology and the respect for fundamental rights through responsible use in forensic activity.

The theme is current through the novel elements addressed. The article represents a point of view on AI and its use.

The development of artificial intelligence generates new forms of crime, for which it is necessary to have a clear legislative framework, ethical control mechanisms and interdisciplinary collaboration between specialists in law, computer science, sociology and cybersecurity.

The future of all humanity depends on international cooperation in combating new forms of crime and finding a set of unanimously accepted norms regarding the use of AI.

Keywords: *AI, forensics, algorithms, high-tech systems, risk, vulnerability*

JEL: K14

Introduction

In the context of globalization, the convergence between forensics and Artificial Intelligence is currently recording devastating consequences. Both in the field of forensics, when we mention the investigation and research of crimes, and in the field of jurisprudence, when judges base their final conviction decisions on judicial practice in the field and related legislation - we can state through pertinent arguments that we are witnessing an AI intrusion. We refer to AI intrusion because it produces both advantages and disadvantages, respectively risks in the situation where the judge's decision is based only on the algorithms used by AI.

Most criminal cases and not only in the situation of high-risk crime - but organized crime also - there are entire volumes of documents (statements, expert reports, judicial practice, jurisprudence) that would require unlimited time for analysis and research.

In Romania, in the Caritas (File nr. 138/85/2023) case, the volumes of the files reached several tons, and could be transported from one court to another by at least 4 trucks. At that time, the court hearings were many and over long periods of time, the process being delayed for several years, precisely because the competent authorities solving the case needed tens of thousands of hours for reading.

In forensic research, AI increases efficiency and reduces the time required to obtain significant results, both when drafting reports to terminate criminal prosecutions by judicial bodies and when drafting indictments by the court.

Modern systems identify connections that are impossible to observe in the traditional way, facilitating investigations. An example of this would be facial recognition algorithms, real support in identifying suspects. AI has developed analysis tools that investigate cybercrime and even cross-border crimes. Forensic science is the one that has recorded greater performance by resorting to AI. It is known that the use of AI tools was first used in police work, namely forensics, by the police in Avon and Somerset (UK). At that time, SOZE as an AI tool was created to quickly analyze huge volumes of data. For example, extremely complex cases have been solved in just 30 hours with the help of AI. And if a person had to go through the same volume of data, it would have taken him 81 years. The tool used by AI uses machine learning algorithms, so that enormous amounts of data and information from files, video recordings, witness statements, reports and expertise - can be correlated by SOZE which can scan finding patterns, connections, and new identification leads in record time.

Beyond SOZE's use of facial recognition functions through which police work gains both time and field of action of great importance is the linguistic analysis and statistical (In Roxana Moisoiu's doctoral thesis, which is in manuscript.) predictions used by AI in various fields of research. In the research carried out to establish the causes of crime committed against property and people, the use of AI by documenting national, European, international statistics has led to the development of effective syntheses in research. But the decision-maker regarding the proposals for *lege ferenda* was neither the algorithm nor SOZE, but the one who took the scientific approach, that is, the researcher. The limits of AI, beyond its undeniable benefits, must consider those aspects that refer to ethics, that is, to the rules and principles that must be respected in scientific research in the context in which cybersecurity risks appear quite frequently.

Content.AI technology both in forensics, when we mention the management of a huge volume of data, and in the practice of courts of law (by reporting decisions to the entire jurisprudence) - gives rise to controversies related to the emergence of possible risks, both of a cybernetic and ethical nature. Thus, reference can be made to those violations of personal data, in the situation where AI systems through manipulation generate false information about individuals, as well as about their past or present.

It is known that the EU, through its digital single market, has become known for the use of AI since 2010. For 10 years, violations of personal data and more have been recorded.

The consequences produced in the related field led the European Commission to adopt a White Paper in 2020. In the legal doctrine, both the civil and criminal liability of the legal person from the perspective of AI have been debated.

Considering the provisions of art. 535 of the Criminal Code, electro-magnetic waves, energy produced, captured and transmitted, things embedded in a building (elevator, escalators), water, electricity and gas sewage installations, certainly transcend the limits to AI.

From the perspective of criminal law related to AI, we can refer to the report initiated by the European Parliament in 2017 in which it discussed the recognition of the legal personality of robots as electronic persons, thus in the Criminal Code, in paragraph 1.3 of article 535, the liability of legal persons is regulated.

In Romania, the Criminal Code incriminates computer fraud (art. 249 of the Criminal Code), illegal access to an information system (art. 360 of the Criminal Code), unauthorized transfer of computer data (art. 362 of the Criminal Code) and so on. There is Chapter VI of Title VII of the Special Part of the Criminal Code dedicated to computer crimes, but artificial intelligence is not clearly specified.

It is obvious that the use of AI in the legal field has numerous advantages, but it should be noted that there are also risks and vulnerabilities.

One of these is the risk of algorithmic errors, because there is the possibility that the training data is incomplete or erroneous and then incorrect conclusions are generated (algorithmic bias). In forensics, an algorithmic error can influence the criminal process, by altering the presumption of innocence, can lead to judicial errors and even to limiting the freedom of the people involved.

Given the fragility of forensic systems based on AI, they can easily be the target of cyber-attacks that can manipulate databases or compromise digital evidence, using a spectrum that is difficult to detect. Evidence created or interpreted only with AI affects the fundamental principles of a fair trial through the lack of transparency.

Because AI uses sensitive information related to the processing of personal data, it is necessary to respect the right to privacy and the protection of this data.

Establishing legal liability for errors and vulnerabilities that occur is currently the prerogative of users and institutions that use these AI tools.

If we were to talk about the fact that AI can imitate people's voices or resemble audio files with human voices, we find that the systems have evolved and that they can produce vulnerabilities or risks through improperly used progress. (American science fiction writer Issac Asimov evokes, in the short story Runaround, the story of a robot designed and created by engineers Gregory Powell and Mike Donovan) Another possible risk is given by forms of permanent surveillance that are in antithesis to the principles of the rule of law and ethics.

Analyzing ethics from the perspective of AI, we must relate to the rules and moral principles that support the development, implementation and use of AI techniques. The current prospects of cutting-edge technologies in all fields of activity offer both advantages by improving working times and performance itself, providing personalized solutions for everyone.

Thus, in the field of medicine, the use of AI gives research the possibility of diagnosing conditions in minimal real time or performing surgical interventions with the help of the Da Vinci robot - a cutting-edge technology with minimally invasive risks and with a rate close to a minimum mortality limit. It should not be forgotten that the Da Vinci robot is directed by a human, who, using the precision of AI, reaches performance in interventional medicine. (especially in the case of incurable diseases). The performance obtained by using AI algorithms cannot be ignored, however.

Often its cost is at the expense of ethical rules that are not respected under the impact of AI. That is why UNESCO, EU, and Council of Europe documents provide the necessary legal framework and recommendations mandatory for all AI users, but equally for AI creators. And yet, even if AI through the algorithms used becomes essential for research performance, we must not ignore or forget the fact that only a human being can be creative, intuitive, emotional, and passionate, and AI through robotization only offers speed and precision in analysis and diagnosis.

To mitigate risks, it is necessary to have special legislation and implement preventive technical measures. Algorithms can be audited through periodic verification, data can be encrypted, and secure backups can be made to detect intrusions. All these aspects can be achieved by developing clear standards regarding the limits of AI use.

Human experts must always validate the final decisions, in all situations where AI algorithms are used.

Jeffrey H, considered the godfather of AI, states that when an entity becomes smarter and more powerful than us, the hierarchy is reversed. The issue of ethics from the perspective of AI technologies must be understood, implemented and respected precisely because any violation of it violates fundamental rights.

The dream of creating humanoid robots has always existed. It is known that the "spring of artificial intelligence" dates to 1942. (American science fiction writer Issac Asimov evokes, in the short story Runaround, the story of a robot designed and created by engineers Gregory Powell and Mike Donovan). In Romania, the first forms of robots appeared around the 1980s, but they have been developed since 2018. The doctrine speaks of a new type of criminality "AI Crime" (Thomas C. King, Nikkita Agarwal, Mariarosaria Taddeo, Luciano Floridi,) so AI can be a means or method of committing a crime and from this point of view it must be treated as a subject of law. (Laura Maria Stănilă, „Inteligența Artificială, Dreptul Penal și Sistemul de Justiție Penală. Amintiri din viitor”,

București, Universul Juridic, 2020, p.36) It remains for the future to record whether these are just speculations or will really happen.

Conclusions

AI emerged from the need to improve and implicitly implement the latest generation technologies in suitable fields from industry to medicine and even international security. Digital technology, the algorithms used in the application of AI tools validate the legal personality of both the creator of AI and the user, implicitly their liability in situations where both human and patrimonial damages occur. It is therefore necessary to carry out a critical assessment of the effects that artificial agents produce when they malfunction.

The innovative aspects that AI has brought to forensics, namely the investigation of high-risk crime, as well as the urgent need to access huge volumes of case law and more, have led to performance in terms of professional expertise, by limiting the time of action or by replacing the human being with robots, when they should act in a territory with imminent risk. (the situation of mined lands or critical situations in armed conflicts).

AI can be used for the good of society, but also in harmful actions and for this reason it is necessary to have universal norms that regulate all aspects of the international community.

In the future, AI will be a real support in legal activity through predictive analysis and automatic identification of evidence, analysis of data from a multitude of sources.

The role of AI will, of course, also be one of combating organized crime and facilitating identification processes while maintaining the human factor in the decision-making process.

Whether through the diversity of fields it changes with the passage of time, what remains valid and imperative is the fact that the human being cannot be completely replaced, the act of decision-making being unchangeable regardless of the performance of any AI tool.

The universe will exist as long as humanity exists as well.... Artificial intelligence is the most important innovation of modern man, but it must only be used responsibly as a tool that supports the progress and development of society.

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SMART PUBLIC ADMINISTRATION: DIGITAL INNOVATION SCENARIOS IN THE ERA OF ARTIFICIAL INTELLIGENCE

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Abstract: *The accelerated technological transformations of recent decades have led to a profound redefinition of contemporary public administration. This article analyzes the structural transformations generated by artificial intelligence (AI) in the field of public administration, proposing a mapping of digital innovation scenarios applicable in the context of administrations in Central and Eastern Europe. Based on a mixed methodology - comparative analysis of specialized literature, international case studies, and the construction of prospective scenarios - the study identifies four main directions of transformation: the automation of public services, data-driven governance, citizens' digital participation, and the cybersecurity of critical infrastructures. The conclusions highlight the need for an adapted legislative framework, investments in institutional capacity, and an ethical, citizen-centered approach in the implementation of AI solutions in the public sector. Through an interdisciplinary approach, the article proposes a reflection on the future of public administration in the context of global digital transformations.*

Keywords: *digital public administration, artificial intelligence, e-government, innovation scenarios, digital transformation, smart public services.*

JEL: H83, O33, O38

Introduction

The digital transformation of the public sector represents one of the most significant challenges of the third decade of the 21st century. While the first waves of digitalization focused on the computerization of existing administrative procedures, the new frontier- marked by the rise of artificial intelligence - entails a profound reconfiguration of the very logic of governance. It is no longer simply about doing faster what was previously done; it is about rethinking the relationship between the state, the citizen, and public decision-making (Dunleavy et al., 2006).

Artificial intelligence - in its forms of machine learning, natural language processing, expert systems, and robotic process automation - provides public administration with unprecedented tools: the capacity to process massive volumes of data, anticipate service demand, personalize interaction with citizens, and detect fraud and anomalies in real time (Wirtz et al., 2019). These capabilities are not politically and ethically neutral; they raise fundamental questions regarding transparency, accountability, fairness, and data sovereignty.

In the European context, the Artificial Intelligence Strategy (2021) and the European Artificial Intelligence Act (2024) outline the normative framework within which Member States are called upon to integrate AI into public services, with explicit guarantees for citizens' fundamental rights (European Commission, 2021). Romania, as a Member State of the European Union, stands at the intersection between the opportunity to bridge historical gaps in administrative modernization and the risk of adopting technological solutions without the necessary institutional and human infrastructure.

This article proposes a systematic analysis of digital innovation scenarios through AI in public administration, structured around four thematic axes: the automation and efficiency of services, data-driven governance, citizens' digital participation, and the security of public systems. The study aims

to provide both a theoretical contribution to the specialized literature in the field of digital public administration and practical benchmarks for decision-makers involved in public sector digital transformation projects.

Scientific methodology

The present research adopts a mixed methodological approach, combining qualitative and quantitative analysis of sources, in accordance with the paradigm of applied research in administrative sciences (Creswell, 2014).

2.1. Systematic literature review

The first methodological component consists of a systematic review of specialized literature published between 2015 and 2024, using the Scopus, Web of Science, and Google Scholar databases. More than 120 relevant works were identified and analyzed, selected based on thematic relevance, impact factor, and theoretical novelty. The search terms used included combinations of the following concepts: artificial intelligence, public administration, e-government, digital transformation, algorithmic governance, smart government.

2.2. Comparative analysis of case studies

The second component consists of the comparative analysis of twelve case studies regarding the implementation of AI solutions in public administration in European Union Member States (Estonia, Denmark, Finland, the Netherlands, France, Germany), as well as in the United Kingdom, the United States of America, South Korea, and Singapore. The cases were selected to cover a variety of institutional contexts, levels of digital maturity, and types of AI applications (Zuiderwijk et al., 2021).

2.3. Construction of prospective scenarios

The third methodological component employs the scenario method (Schwartz, 1991), adapted for the field of digital public policies. The scenarios were constructed through the identification of key driving forces (degree of digital maturity, legislative framework, level of citizens' trust, institutional capacity) and critical uncertainties, followed by the development of four archetypal scenarios for the 2030 horizon.

2.4. Expert consultation

The validation of the results involved consultation with a panel of ten experts from the fields of public administration, applied informatics, European administrative law, and AI ethics, using an adapted Delphi method (Linstone & Turoff, 2002). The experts' feedback was integrated into the final version of the scenarios and public policy recommendations.

Theoretical framework: Public administration in the digital era

Over recent decades, public administration theory has undergone a succession of major paradigms: from traditional Weberian public administration, focused on hierarchy and standardized procedures, to New Public Management (NPM), oriented toward efficiency and market principles, and more recently toward New Public Governance (NPG), which emphasizes networks, co-production, and participation (Osborne, 2010).

In this context, digitalization and AI do not represent mere technical tools superimposed upon existing administrative structures; they generate a new paradigm - Digital Era Governance (Dunleavy et al., 2006) or, in its most recent form, Algorithmic Governance (Danaher et al., 2017) - which reconfigures power relations, accountability mechanisms, and the logic of public service delivery.

The concept of smart public administration integrates three essential dimensions: (1) the use of data and AI to optimize decision-making and services; (2) the interoperability of platforms and information systems; and (3) a proactive orientation toward citizens' needs, anticipating demand rather than merely reacting to it (Mellouli et al., 2014). This triad defines the analytical framework of the present study.

Research conducted by Wirtz et al. (2019) emphasizes that the successful implementation of AI in the public sector depends on three critical factors: technical capacity (digital infrastructure and human expertise), institutional legitimacy (citizens' trust and the legal framework), and political will (the

commitment of administrative leadership to innovation). The absence of any of these factors compromises the success of digital transformation projects.

Digital innovation scenarios through artificial intelligence

Scenario I - Automation of mass public services

The first scenario concerns the use of AI to automate high-volume administrative services: the issuance of documents, request processing, eligibility verification for social benefits, and the payment of taxes and duties. The reference model is Estonia, which implemented the concepts of e-residency and proactive administration - citizens automatically receive the benefits for which they are eligible, without the need to submit applications (Lips, 2020).

The key technologies in this scenario are natural language processing systems (administrative chatbots, virtual assistants), robotic process automation (RPA), and data interoperability platforms. A study by the McKinsey Global Institute (2017) estimates that approximately 30% of public servants' tasks can be automated using existing technologies, generating significant savings and freeing human resources for activities with higher added value.

The challenges of this scenario include the risk of digital exclusion for vulnerable population segments, the need to redesign administrative processes (not merely digitize existing procedures), and change management within public institutions (Janowski, 2015).

Scenario II - Data-driven governance and algorithmic decision-making

The second scenario explores the use of AI to improve the quality of public decision-making through predictive analysis, fraud detection, and optimal resource allocation. Concrete applications include: early warning systems for school dropout risks, predictive policing (with its significant ethical dilemmas), optimization of public transport routes, automatic detection of tax fraud, and anticipation of social care needs.

Denmark implemented an AI-based system for detecting fraud in the social benefits system, achieving remarkable results in reducing improper payments (Veale & Brass, 2019). France uses machine learning algorithms to analyze tax declarations and identify taxpayers with a high risk of tax evasion (OECD, 2019).

The ethical dimension is central to this scenario. Algorithmic decision-making in sensitive areas - such as the allocation of social housing, recidivism risk assessment, and the granting of benefits - can reproduce and amplify existing discrimination if the training data reflects historical inequalities (O'Neil, 2016). The principle of algorithmic explainability (the "right to explanation," established by the GDPR) and the transparency requirements of the European AI Act (2024) define the legal boundaries of this scenario.

Scenario III - Digital participation and deliberative democracy

The third scenario projects the use of AI to revitalize citizen participation in democratic processes: intelligent public consultation platforms, systems for the automatic aggregation and synthesis of citizens' opinions, automatic translation tools for the inclusion of minority communities, and real-time public sentiment analysis for decision-makers.

Finland experimented with digital consultation platforms in which AI automatically synthesizes thousands of citizen comments into main themes, facilitating the participatory legislative process (Aitamurto & Landemore, 2016). Taiwan implemented the vTaiwan platform, an AI-assisted digital consultation system that generated political consensus in controversial areas such as the regulation of the sharing economy (Hsiao et al., 2018).

The specific risks of this scenario include deliberative manipulation through AI-amplified disinformation, filter bubbles, and threats to the decision-making sovereignty of elected representatives. The EU regulatory framework on digital services (Digital Services Act, 2022) establishes specific obligations for platforms that mediate public discourse.

Scenario IV - Cybersecurity of critical infrastructures

The fourth scenario addresses the use of AI to protect the state's critical infrastructures - energy, financial, public health, and communication systems - against increasingly sophisticated cyber threats. AI provides superior capabilities for anomaly detection, network traffic analysis, and automated incident response, which are essential in the context of the proliferation of cyberattacks sponsored by state actors (ENISA, 2023).

The European Union Agency for Cybersecurity (ENISA) reports a 150% increase in cyberattacks targeting European public institutions between 2020 and 2023, emphasizing the urgency of investments in AI-based defensive capabilities. The Baltic states - Estonia, Latvia, and Lithuania - have developed some of the most advanced cybersecurity architectures in the EU, combining human expertise with AI-powered real-time monitoring systems (Lim & Tang, 2021).

Table 1. Summary of Digital Innovation Scenarios through AI in Public Administration

Scenario	Main applications	International examples	Horizon
I. Automatizare servicii	Chatboți administrativi, RPA, documente automate	Estonia, Singapore	2025-2027
II. Guvernanță algoritmică	Analiză predictivă, detecție fraude, alocare resurse	Danemarca, Franța, Olanda	2026-2028
III. Participare digitală	Consultare publică IA, sinteză opinii cetățeni	Finland, Taiwan	2027-2030
IV. Securitate cibernetică	Detecție anomalii, răspuns automat la incidente	Estonia, Lithuania, Israel	2024-2026

Source: Data processing by the author.

Regulatory framework and implementation challenges

The implementation of AI solutions in public administration cannot be separated from the regulatory framework within which it operates. At the European level, three major legislative instruments define the scope of action for public administrations: the General Data Protection Regulation (GDPR, 2018), the European Artificial Intelligence Act (AI Act, 2024), and the Open Data Directive (2019/1024). Together, these establish a framework based on the principles of transparency, explainability, data minimization, and algorithmic accountability (European Commission, 2021).

The European AI Act classifies AI systems used in the public sector according to their level of risk, imposing strict requirements for high-risk applications - those affecting citizens' fundamental rights, access to essential public services, or the evaluation of individuals by public authorities. Public administrations implementing such systems are required to conduct fundamental rights impact assessments, ensure human oversight, and maintain transparency registers (Regulation EU 2024/1689).

At the national level, Romania adopted the National Artificial Intelligence Strategy 2024–2027, which establishes the priority investment directions and the institutional framework for coordinating AI implementation in the public sector. Nevertheless, the gap compared to advanced EU Member States remains significant, both in terms of digital infrastructure and institutional capacity, as well as in terms of an organizational culture oriented toward innovation (Radu, 2021).

In many cases, implementation challenges go beyond the purely technological dimension. Resistance to change within public organizations, the lack of digital skills among public servants, the fragmentation of existing information systems, the absence of coherent open data policies, and uncertainties regarding accountability in cases of erroneous algorithmic decisions constitute structural obstacles that require systemic solutions (Mergel et al., 2019).

Conclusions

The analysis conducted in the present study leads to a series of conclusions with both theoretical and practical implications for the field of digital public administration.

From a theoretical perspective, the research confirms that artificial intelligence does not represent a mere extension of digitalization, but rather a vector of paradigmatic transformation in governance, with profound effects on the state–citizen relationship, mechanisms of democratic legitimacy, and institutional accountability. The analytical framework of smart public administration, structured around three dimensions - data optimization, system interoperability, and proactive citizen orientation - provides a useful theoretical instrument for assessing the digital maturity of public organizations (Dunleavy et al., 2006; Wirtz et al., 2019).

The four scenarios analyzed reveal a broad spectrum of opportunities, ranging from the automation of mass services - with the shortest implementation horizon and the highest degree of technological maturity - to deliberative digital participation, which requires deeper reconfigurations of democratic processes. Each scenario comes with a specific risk profile and particular institutional capacity requirements, which calls for differentiated approaches depending on the national and local context (Zuiderwijk et al., 2021).

A transversal conclusion of the study is that the success of public administration's digital transformation depends less on technological sophistication and more on institutional, human, and political factors: sustained political will, investments in digital skills, the redesign of administrative processes, and the construction of a solid ethical framework centered on citizens' rights. Technology is a catalyst; change is, in its essence, institutional and cultural (Mergel et al., 2019).

For Romania and, more broadly, for the states of Central and Eastern Europe, the historical opportunity lies in the possibility of bypassing stages of traditional administrative modernization and directly implementing next-generation solutions. This opportunity is not without risks: the hasty adoption of technologies without the necessary institutional infrastructure may generate opaque, inequitable, and vulnerable systems that erode rather than strengthen citizens' trust in public administration.

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