

# DIGITALIZATION OF CUSTOMS PROCEDURES AND SUPPLY CHAIN RESILIENCE: ADAPTATION STRATEGIES IN A VOLATILE ECONOMIC ENVIRONMENT

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**Abstract:** Most countries in the world are open economies. Cross-border trade is important for these countries in both times of prosperity and times of crisis. This article explores the impact of customs digitalization on the resilience of international logistics chains. The author conducts a comparative analysis of the levels of digitalization across different customs services and their roles in reducing transit times and increasing transparency. The conclusions indicate that digitalization not only optimizes operational costs but also provides operational statistical data necessary for effective and rapid decision-making. The study's results showed that all open economies have, to varying degrees, implemented digital technologies in their customs systems. Therefore, in the modern era, digitalization is no longer just an additional competitive advantage but has become a prerequisite for building sustainable logistics networks.

**Keywords:** *digitalization, customs procedures, logistics, economic volatility.*

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## Introduction

In the midst of global crises, the digitalization of customs is no longer a technological luxury but a condition of economic survival. When uncertainty becomes the new rule, the resilience of supply chains directly depends on a single factor: the maturity of the digital infrastructure at the border. This analysis explores how technology transforms bureaucracy into a shield against market volatility. Resilience in logistics consists not only of the ability to protect against risks but also of the ability to adapt in real time. Contemporary specialized literature frequently uses the Theory of Dynamic Capabilities and the Theory of Complex Adaptive Systems to explain how organizations can survive in times of crisis. In this case, traditional administrative barriers are leveled while the flow of data and goods is accelerated.

Recent research shows that the relationship between Customs digitalization and resilience is influenced by unstable supply chain dynamics and newly introduced administrative regulations. While the introduction of digital technologies provides tools for rapid response to challenges, the implementation of ever-new administrative burdens creates effects that diminish the effectiveness of technologies. Single Window systems and data platforms are not just technical tools, but strategic assets. From a resource perspective, a solid customs digital infrastructure creates a competitive advantage that is difficult to replicate, providing stability and speed to the entire commercial ecosystem, not just the state.

The integration of technologies such as Artificial Intelligence (AI), Blockchain, and the Internet of Things (IoT) into the customs ecosystem has generated a profound transformation in the way authorities monitor and facilitate trade. These tools provide not only efficiency, but also the transparency needed to identify vulnerabilities in real time.

Blockchain technology seemed to be a solution to solving data integrity issues in international transactions. Thanks to the use of distributed ledgers, customs officers can verify the origin of goods, certificates of conformity, and transport documentation, avoiding the control of physical documents. Platforms such as TradeLens demonstrate that digitizing documentation through blockchain reduces customs clearance time by up to 40% at seaports (Zeya, 2025).

Y. Tian and L. Cui argue that digitalization is a key determinant of supply chain resilience, exerting significant and sustained positive impacts on companies within the network. Such digital technologies as IoT sensors, blockchain, and artificial intelligence are being deeply embedded in all stages. It was being introduced in order processing, logistics, and influence, reducing information asymmetries and accelerating decision-making. The authors emphasize that increased resilience is primarily driven by improved companies’ information processing capabilities, their recovery capabilities, and inventory turnover efficiency (Tian & Cui, 2025).

Y. Wei noted that digital intelligence represents the deep integration of digitalization and intelligent technologies. It becomes a crucial tool for restoring and strengthening the resilience of regional supply chains in a volatile external environment. In his study, the author emphasizes that no single factor can ensure a high level of resilience; this result is achieved exclusively through the synergistic interaction of multiple elements (Wei, 2025).

H. Johnson argues that in the face of global uncertainty, supply chain resilience has transformed from a crisis response mechanism into a strategic necessity for ensuring long-term business survival (Johnson, 2025).

M. Weber, U. Aumüller, and P. Franke noted that digitalization and Industry 4.0 technologies are critical tools for improving supply chain resilience, enabling systems to effectively adapt to unexpected disruptions and quickly restore operations. The authors emphasize that the use of big data analytics and simulation modeling facilitates the transition from simply describing the current state to making “optimal” decisions based on the calculation of various scenarios. The implementation of technologies such as blockchain and artificial intelligence helps minimize information asymmetries and create transparent, secure databases necessary for strategic planning in volatile environments. However, the researchers point out the limitations of digitalization, including the difficulty of harmonizing IT systems across various partners, the risk of cyberattacks, and the need to adapt the legal framework. (Weber et al., 2023).

**Macroeconomic Indicators of Logistics Performance**

Empirical data from the 2023 IPL reveal a deep, persistent, and structural performance gap between high-income and low-income nations, a divide based largely on technological disparities and the variable quality of digital logistics services. High-income countries have a significantly higher average IPL score of around 4.0 on a 5-point scale, with an average of fifty percent of these nations scoring between 3.5 and 4.2.4 In contrast, low-income nations have an average score of around 2.0, with their average percentile being heavily concentrated between 1.8 and 2.4 (Table 1).

**Table 1**

**Comparative Analysis of Logistics Performance Index (LPI) Scores by Income Cohort (2023)**

| Income Cohort         | Median Overall LPI Score (2023) | Score Distribution (Middle 50%) | Representation in Top 33 Performers |
|-----------------------|---------------------------------|---------------------------------|-------------------------------------|
| High-Income Countries | ~4.0                            | 3.5 - 4.2                       | 30                                  |
| Low-Income Countries  | ~2.0                            | 1.8 - 2.4                       | 0                                   |

Source: Systematized by the authors (World Bank, 2023).

Of the 33 best-performing countries globally in the 2023 index, 30 belong to the high-income cohort, a statistical reality that has remained largely unchanged in previous editions of the LPI.

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### **Adaptation strategies in volatile economic environments**

The Single Window is the core of modern customs digitalization, namely, this system allows economic agents to submit all the documentation required for international trade using a single digital portal. This system brings such benefits as eliminating data re-entry errors and improving coordination between various branches of government, such as customs or finance. However, implementation remains a major challenge due to the lack of interoperability between different national systems and resistance to change within bureaucratic structures.

Analysis of the LPI indicator suggests that the performance gap between high-income and low-income countries is significant, and is determined by the technological gap and the quality of logistics services. To ensure resilience, states and international organizations have developed adaptation strategies based on three main pillars: regulatory harmonization, public-private cooperation, and investment in human capital. The fragmentation of digital regulations represents a systemic risk for global trade, consisting of a set of contradictory rules. The global adaptation strategy involves the adoption of the WCO Data Model, which provides a universal language for information exchange.

National Trade Facilitation Committees (NTFCs) play a key role in adapting customs policies to market realities. Through these forums, the private sector, as a major user of customs services, can provide direct feedback on the efficiency of digital procedures (Gutium, 2023). The Global Alliance for Trade Facilitation projects demonstrate that public-private partnerships can accelerate digitalization by co-creating technical solutions that are both secure for the state and user-friendly for business.

The success of digitalization does not depend solely on software code, but on the people who operate these systems. Studies conducted within customs administrations show that adaptive cultural values, integrity, and continuous investment in digital skills of officials are critical mediators between digital transformation and organizational performance. Without a motivated and trained workforce, even the most advanced AI systems can fail to achieve resilience goals.

### **Customs reform in the European Union and digital challenges**

The European Union is going through a period of profound legislative and operational transformation, aimed at adapting the Customs Union to the challenges of the 21st century. The reform proposed in 2023 and politically supported in 2025 aims to centralize data and accountability to counter the current fragmentation between the 27 national systems (European Parliament, 2024).

At the heart of this reform is the Customs Data Hub, a single digital platform that serves as an interface for all economic operators importing or exporting to the EU. This infrastructure

will allow authorities to have a single view of the entire supply chain, eliminating the need to submit the same data in multiple Member States.

An innovative element is the introduction of the “Trust & Check” operator category. These are traders who provide customs authorities with transparent access to their real-time logistics data, in return for which they receive the benefit of moving goods across the border without any systematic physical or administrative intervention. This adaptation strategy shifts the center of gravity of control from the individual transaction to the company's risk management system, significantly increasing the speed and predictability of deliveries.

Global alliances such as the Global Alliance for Trade Facilitation, supported by the International Chamber of Commerce and the World Economic Forum, have demonstrated that public-private partnerships are an effective model for promoting digitalization and e-commerce. There are already visible results, including in the world's most vulnerable economies (LDCs - Least Developed Countries).

At the national level, these strategic collaborations are most effectively formalized by creating institutionalized platforms where public representatives and private actors organize regular meetings to analyze logistical problems and propose solutions to optimize cross-border flows. Such alliances have brought benefits through structures such as the Economic Council under the Prime Minister of the Republic of Moldova and the Consultative Council of the Customs Service in Chisinau. Through them, aspects of the application of the new pro-European Customs Code, the administrative impact of digitalization requirements, and strategies for protecting the business environment are discussed (Gutium, 2021). The activity supported by international donors, such as the German International Cooperation Agency in the Republic of Moldova, also represents an important pillar in the information campaign.

For regional and international supply chains to become fully resilient, rigorous international regulatory harmonization is necessary. The lack of a unified, predictable, and mutually recognized governance framework for the protection of confidential data can create significant non-tariff barriers to the mutual recognition of cross-border electronic documents. This situation leads to situations where documents sent digitally instantly still have to be printed, stamped, and physically brought by the truck driver to the border customs checkpoint.

Large-scale innovative projects, such as the European SEED model (successfully implemented also between Romania, Moldova and Ukraine) and the European Commission's ambitious initiative to create the future EU-wide customs data hub (EU Customs Data Hub), represent exactly the type of solutions needed to combat the problem of data silos, a systemic problem in which different state agencies store the same data in isolated systems, unable to communicate with each other. Eliminating fragmentation of IT systems and imposing technical interoperability standards through legislation allows for an invisible, continuous, and secure information flow, allowing multiple border agencies to act synergistically, simultaneously, within a genuine Single Window ecosystem.

The interconnection of national servers inevitably introduces an increased risk of cyberattack. Protecting national systems and IT networks of thousands of authorized economic operators against cyberattacks that can paralyze global port terminals or customs offices of some countries has transformed “cyber resilience” into a critical and inseparable component of the resilience of the global supply chain. Modern customs administrations must establish and enforce a rigorous trust framework, based on ISO information security standards, that requires and independently validates the cybersecurity maturity levels of all their business partners in the logistics chain, thus ensuring the integrity of the entire cross-border ecosystem.

The exhaustive empirical and theoretical analysis of the complex intersection between the digital transformation of customs procedures and the development of the concept of resilience of international logistics chains reveals an unequivocal conclusion, validated by both the

specialized literature and the activity reports of international organizations: digital maturity at the border has long ceased to be a simple competitive differentiator or a governmental image exercise, becoming an absolute existential necessity for navigating the volatile, unpredictable and often hostile economic environment of the present.

Systemic macroeconomic and logistical disruptions induced by factors that are difficult to predict, such as global pandemics (COVID-19), maritime channel blockages, inflationary crises and, most recently, the devastating consequences of wars – aspects eloquently illustrated by the case of the Black Sea basin impact and the massive, emergency reconfiguration of continental trade routes through the Republic of Moldova and Romania – have definitively emphasized the imperative of irrevocably abandoning administrative procedures based on paper-based documentary support, stamps and intensive manual physical intervention. Integrated digitalization of customs systems – operationally translated by the mandatory adoption of data pre-processing before the physical arrival of goods, the implementation of the inter-agency electronic Single Window architecture, and the national integration of the New Computerized Transit System (NCTS Phase 5) for fluid trade.

In addition to directly optimizing transaction costs and shortening transit times, digitalization strengthens three pillars of trade resilience. Such as the capacity to passively absorb logistical shocks, the agility to respond quickly during a crisis, and the efficiency of the post-crisis operational recovery process. By generating unprecedented end-to-end visibility – the ability to know exactly where a cargo is and what its customs status is, at any given second – and by providing vital statistical data sets in real time, customs authorities are structurally transforming themselves: from a historical bottleneck (traditional bottleneck in the logistics flow), they are becoming a central hub for generating decision-making data, data that is indispensable to private companies for scenario planning exercises, for implementing nearshoring strategies, and for the geographical diversification of global networks.

### **Conclusions**

In conclusion, we can say that in the context of global instability, government administrations that fail or indefinitely postpone the adoption of this qualitative technological and organizational leap risk massive fiscal losses in the short term and the marginalizing exclusion of their own national economies, and implicitly their citizens, from the complex networks of global value chains in the long term. The strategic acceleration of the customs digital transformation process, the total alignment with the operational standards promoted by recognized international bodies, and the deepening of regional cooperation remain, undoubtedly, the most efficient, secure and proven mechanisms for guaranteeing national economic security, facilitating legitimate competitive trade and the resilience of macroeconomic systems at a global level in the first decades of the twenty-first century.

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