Formation of a Mechanism for the Development of an Industrial Enterprise in the Context of Digitalization

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Abstract

The purpose of this article is to examine the mechanism for industrial enterprise development in the context of digitalization. A system of key elements is proposed that forms the mechanism for industrial enterprise development in accordance with the Industry 4.0 concept. Distinctive features of the proposed system include characterizing all elements of the mechanism from the perspective of digital technology implementation, as well as describing the areas of transformation, taking into account the specific features and changes that occur with the implementation of digital solutions. The results of the study can be useful in developing industrial enterprise development strategies in accordance with the Industry 4.0 concept. The digital transformation of industrial production enables increased flexibility, productivity, quality, and customer focus, providing enterprises with a competitive advantage. The relevance of this research is determined by modern requirements for the multi-component nature of industrial production, the complex systems used in organizing production processes, and the ever-increasing technological sophistication of modern industrial products. This determines the objective of the study: to identify and scientifically substantiate the key features of organizing industrial production in the context of digitalization. To this end, the following objectives must be achieved: reviewing research on this topic; identifying the key elements of organizing industrial production in the context of digitalization; and developing a sequence for organizing industrial production in the context of digitalization. Successful resolution of these objectives allows us to substantiate the author's hypothesis about the key role and place of a properly developed technology for organizing industrial production in order to meet modern requirements for the digitalization of production.

Keywords: Industrial enterprises, Mechanism, Development, Digitalization, Digital technologies, Industry 4.0

JEL Codes: Q01, Q56, R11, Z32

Received: 28.02.2026

Accepted: 23.03.2026

Published: 31.03.2026

https://doi.org/10.54414/ZEXU4283

1. Introduction

Digitalization implies deep integration of various information systems and technologies within an enterprise, enabling end-to-end management of production processes, logistics, maintenance, and other functions, collection, processing, and analysis of big data, remote monitoring and control, adaptability and flexibility of production, and interaction with external ecosystems (Klaus & Devis, 2018). The collection, processing, and analysis of big data through the use of digital sensors and data collection systems in production generate large volumes of information. The application of big data analytics methods allows us to identify patterns, optimize processes, and make more informed decisions. Modeling and simulation of production systems are based on the use of digital twins for virtual testing and optimization of production, enabling the rapid modeling and prototyping of new products and production lines (Trachuk & Linder, 2020). Remote monitoring and control enable remote

management, control, and diagnostics of production assets, and contribute to increased efficiency of equipment maintenance and repair. Adaptability and flexibility of production due to the rapid reconfiguration of production to changing market needs increase the enterprise's ability to adapt to changes in demand and market conditions. Interaction with external ecosystems by integrating enterprise production systems with the digital platforms of suppliers, customers, and logistics providers. Expanding opportunities for cooperation and collaboration within production value chains.

In recent years, the processes of business transformation under the influence of digital technologies have attracted particular interest from researchers and economists. Industrial enterprises committed to digital transformation must develop a methodological base, taking into account the gradually accumulating empirical results and new technological conditions. Enterprise digital transformation must be implemented through a regulated and targeted process that will enable goals to be achieved within a specified timeframe with optimal resource expenditure. This refers to the mechanism for enterprise development in the context of digitalization. Thus, every enterprise is interested in researching, creating, and improving its development mechanisms. This suggests that the topic of developing a mechanism for industrial enterprise development in the context of digitalization is relevant.

2. Literature Review

Issues related to defining the essence of this mechanism as a separate economic category have been addressed by economists such as L. Gurvits, A. Kulman (Kulman, 1993), N. Ivanov, A.N. Bychkova, and others. Research into the mechanisms of sustainable enterprise development was conducted by V.G. Byazrov, E.V. Shestakova, and V.F. Tsakhilova. It is important to note that all authors, when considering this topic, predominantly adopt a systems approach. Issues related to the study of the impact of digital technologies on enterprise activities and the formation of mechanisms for enterprise development in new technological conditions are reflected in the works of A.V. Babkin (Babkin et al., 2022), L.K. Agaeva, A.G. Shcherbakov, and N.S. Vasin, I.G. Gorlovskaya, E.P. Kozlova. However, the research results do not sufficiently reflect the need for enterprises to create a strategy for the implementation of digital solutions as a methodological basis. Thus, existing approaches to the formation of a development mechanism in the context of digitalization, in our opinion, require further clarification and development.

The aim of the article is to study the content of the mechanism for the development of an industrial enterprise in the context of digitalization. In accordance with the aim, the following tasks have been defined: analysis of sources in order to study the essence and features of the concepts of "mechanism", "economic mechanism", "organizational and economic mechanism", "development mechanism"; based on the systematization of the research results of economists, to determine the system of basic elements of the mechanism for the development of an industrial enterprise; To propose the basic elements and examine the specific features of an industrial enterprise development mechanism in the context of digitalization.

3. Methodology

The methodological basis of this study is a systems approach, as well as methods of analysis, generalization, and comparison. The scientific hypothesis is that the most general factor in shaping an enterprise's development mechanism in the context of digitalization is the creation of a strategy for implementing digital solutions. The scientific novelty of this work lies in the following. A system of basic elements is proposed that forms an industrial enterprise development mechanism in accordance with the Industry 4.0 concept. Distinctive features of this system include the use of a process approach and the specification of the "transformation area" element, which acts as the object of direct change. The key stages of developing a strategy for implementing digital solutions as the primary tool for an enterprise's development mechanism in the context of digitalization are proposed.

Having analyzed the works of economists, it can be concluded that the definitions of the economic mechanisms proposed by them are rigorous, universal, and applicable to studies at all levels of the hierarchy (macro, meso, micro). The authors examine the economic mechanism in terms of interactions or processes. L.

Gurvits defines a mechanism as a process of interaction between its constituent elements. A. Kuhlman's achievement is the definition of an economic mechanism as a process with a defined outcome, and its division into closed and open (Kulman, 1993). N. Ivanov subdivides mechanisms into market mechanisms, where hierarchy predominates, and information-network mechanisms, based on horizontal interactions between elements. A.N. Bychkova proposed the following classification of economic mechanisms: management mechanisms (top-down), interaction mechanisms, and regularity-based mechanisms.

M. L. Krichevsky and his co-authors propose a comprehensive methodology for assessing the digital maturity of enterprises, based on a systems approach and taking into account both internal and external factors of digital development (Krichevskiy et al., 2022). Key attention is paid to the distinction between the actual level of maturity and the target state, determined by the company's strategic objectives and the characteristics of the competitive environment. The model developed by the authors includes a multifactor system of indicators grouped into six areas: strategic management, infrastructure, technology, personnel, organizational processes, and interaction with external contractors. Each area is accompanied by a system of significance coefficients, allowing the methodology to be adapted to the specifics of a particular enterprise. The integrated digital maturity indicator is calculated using a formula based on the principles of weighted summation.

The digital passport model for an industrial organisation is currently the most widely used and institutionalised form (Trachuk & Linder, 2020). A three-loop assessment structure is part of the methodology:

– first loop – digitalisation of key industrial procedures;

– second loop – the level of digitalization of auxiliary functions;

– the third circuit – the advancement of IT infrastructure technology.

Specifically, A. V. Babkin, E. V. Shkarupeta, and associates suggest a thorough method that evaluates the digital gap between the present and intended states (Babkin et al., 2022). Formula 1 is used in the process to determine the digital divide index:

$$D = \frac{Z_c - Z_f}{Z_c} \times 100\%, \quad (1)$$

What is the enterprise's actual maturity level, and where is the goal maturity level for each area? The generated values enable businesses to be categorised based on levels that range from "digital lag" to "progressive maturity." Scales for evaluating employees' digital competencies as well as the digitalisation of processes are also part of the technique.

M. L. Krichevsky, who created a multi-indicator model based on a weighted evaluation of six blocks (Krichevskiy et al., 2022): strategy, infrastructure, technology, processes, personnel, and external relations, offered an alternative method. The model can be customised to the unique circumstances of the business since each component is given a weighting coefficient based on industry peculiarities. A weighted summation formula (Formula 2) is used to determine the integrated digital maturity index:

$$Z = \sum_{i=1}^{n} K_i \cdot V_i, \quad (2)$$

where is the weighting coefficient for the i-th area, and is the maturity indicator value for this area. A comparison of the methods taken into consideration reveals certain similarities:

– extensive use of expert assessment and self-assessment principles;

- focus on complex parameters, including both technological and organizational indicators;
- a tendency to incorporate aspects of digital culture and personnel into the maturity framework.

Simultaneously, there are variations in the aggregate logic, the scales' structure, and methods for displaying the outcomes. For instance, the Babkin and Krichevsky models (Babkin et al., 2022; Krichevskiy et al., 2022) concentrate on the strategic interpretation of maturity and its implementation in management, whereas the digital passport model (Trachuk & Linder, 2020) stresses the functional completeness of process coverage.

Thus, domestic approaches to digital maturity assessment demonstrate progress toward institutionalizing methodologies, but require unification of criteria and the development of external verification mechanisms. Ensuring the comparability of results across enterprises and the creation of independent assessment tools free from the influence of subjective factors remains a pressing issue.

Thus, it can be concluded that these terms encompass both organizational and managerial aspects. When examining economic mechanisms, their organizational component is not negated. The definition of an organizational-economic mechanism distinguishes between organizational and economic aspects. Definitions of a sustainable development mechanism (Ilina, 2021; Alieva, 2022) are provided in Part III. This category, along with the organizational one, must be considered in the study, as every enterprise and its external environment change, and this is an objective reality. Within the framework of our study, "forming a development mechanism" can be interpreted as creating a way to improve enterprise performance in an environment of constant change and external influences. The structure of an "industrial enterprise development mechanism" includes a system of basic components that constitute a single, integrated complex. This concept cannot be considered solely in the context of management and organization, interpreted as an unchanging system, or ignored in terms of goals and results. Thus, through an analysis of scientific sources, we will identify the main elements of an enterprise development mechanism.

4. Current State of the Enterprise

Within the framework of the study, taking into account the category "development," the current state of the enterprise represents the initial state of the system, the "input of the mechanism." An analysis of the current state is essential, as its results are the vector of the enterprise's development (Gileva et al., 2021).

Enterprise goals: These are based on the results of an analysis of the existing enterprise strategy, combined with the capabilities and expected results of the development mechanism.

Transformation areas: By analyzing the current state as a starting point and setting goals, areas of the enterprise requiring updates and changes are identified.

Methods and tools: These represent a set of techniques that ensure the interaction of system elements and are necessary for achieving the stated goals. This coordinated interaction is achieved by influencing the transformation areas.

Internal and external factors: In addition to methods, internal and external environmental factors influence the mechanism. To ensure sustainable, effective development, it is necessary to analyze the impact of each factor on the outcome. Internal environmental factors are generated and developed by the enterprise itself; therefore, in this case, control is transparent, and the degree of influence depends on the enterprise itself.

Operational management includes aspects of production organization and is a means of coordination. It is highly intelligent, flexible, and responds instantly to changes and makes adjustments.

5. Expected Results and Efficiency

The theoretical outcome of enterprise development, achieved through a project-based approach, takes into account the proper interaction of all the components described above, as well as the development of a results monitoring system.

Considering the category "development," this represents the "mechanism output" or the practical results of the mechanism's operation over a period of time determined by management.

Thus, having examined the main elements, we conclude that they are integrated and interact, as well as the need for each component of the mechanism to function as a coherent system. As noted above, the content of the mechanism depends on the company's chosen goals, the direction of strategic development, and the operating conditions. In the next stage of the study, an approach to developing a mechanism for industrial enterprise development in the context of economic digitalization will be proposed.

6. Development Mechanism in Digitalization Context

Currently, in the context of digitalization, enterprises must keep up with modern trends to remain competitive, improve, and develop new markets (Shpak, 2022). Industrial enterprises face a number of conditions that hinder their digitalization development, including the obsolescence and deterioration of production and process chains, as well as low personnel qualifications.

One of the most well-known theoretically validated models is the Industry 4.0 Maturity Index, developed by a German scientific consortium with the participation of Fraunhofer IAO and Acatech (Frolov et al., 2019). The model's structure includes six levels of digital maturity: from computerization to adaptability, as well as four assessment areas: resources, information systems, organization, and corporate culture. The transition between levels is interpreted as a gradual increase in the capabilities of autonomous analysis, decision-making, and self-learning. The model is applied through self-assessment followed by expert verification. The full text of the methodology is available on the official Acatech website. Digital maturity levels according to this methodology are presented in Table 1.

Table 1. Digital maturity levels in the Industry 4.0 Maturity Index model.

Maturity Level	Characteristic
Computerization	Basic automation using IT
Coherence	The presence of integration and data exchange between systems
Visualization	Analytical representation of key processes
Predictability	Predictive analysis and scenario modeling
Autonomy	The ability to make decisions without human intervention
Adaptability	Self-learning systems that can be customized based on the results of their own analysis

Source: compiled by the authors based on (Frolov et al., 2019).

The Digital Capability Framework (DCF), another popular instrument, is employed in international business settings. Strategy, digital leadership, culture, IT architecture, innovation management, and customer experience are the six domains of digital capabilities included in the model. Maturity levels and indicators are used to describe each domain, enabling both qualitative and quantitative evaluation. The DCF places more emphasis on the strategic management of digital projects and sustainable development than models that concentrate on industrial processes (Ilina, 2021; Alieva, 2022).

Significant advancements have also been made to the Smart Industry Readiness Index (SIRI) concept, which was created in Singapore for small and medium-sized industrial businesses. The sixteen components of the methodology are divided into three blocks: organisation, technologies, and processes. The SIRI's high level of visualisation is one of its unique features; the resulting maturity profile is shown as a radial diagram, vividly illustrating the advantages and disadvantages of digital progress. The application of the DEMATEL model, which uses cause-and-effect matrices to identify essential digital maturity aspects, is also significant. This approach, which is widely utilised in Southeast Asia, enables the ranking of maturity characteristics as well as the identification of dominating areas of influence that call for managerial intervention. International techniques can be compared to find commonalities:

– comprehensive coverage of all areas of digital transformation;

- a hierarchical structure with clear criteria for transitioning between levels;
- a focus on managerial interpretation and visualization of results;
- the presence of a mechanism for external verification of the obtained data.

It should be mentioned that digital maturity evaluation is regarded as one of the management instruments for digital sovereignty, competitiveness, and industrial safety in many nations and is incorporated into industrial development programmes.

The great maturity of approaches based on repeatable and quantifiable indicators is thus demonstrated by global experience. However, differences in infrastructure and regulations make it difficult for them to be directly adopted in the sector, requiring procedures for adaptation and modification.

The variety of digital maturity evaluation models now in use is a result of both industry peculiarities and variations in application goals. We may determine each method's advantages and disadvantages as well as its potential for integration, modification, and translation into the actual management of industrial companies by conducting a comparative analysis.

Four models are summarised and compared in Table 2. The Industry 4.0 Maturity Index, the Babkin et al. model, the Digital Enterprise Passport (DEP), and the Smart Industry Readiness Index (Gileva et al., 2021). The following standards form the basis of the analysis:

- comprehensive coverage of digital transformation areas;
- the presence of structured maturity levels;
- applicability for internal and external audits;
- adaptability to industry specifics;
- availability of tools and transparency of calculations.

Table 2. Comparative analysis of digital maturity assessment models.

Criterion / Model	Digital Passport	Babkin's Model and Others	Industry 4.0 Maturity Index	Smart Industry Readiness Index
Completeness of coverage	high	average	high	high
Maturity levels	Yes	Yes	Yes	Yes
Applicability to audit	limited	internal	external and internal	external and internal
Adaptation to the industry	partial	Yes	limited	high
Transparency of calculations	partial	high	average	high

Source: compiled by the authors.

A comparative analysis revealed that models developed by international institutions (Industry 4.0 Maturity Index and SIRI) are highly formalized, have an integrated maturity hierarchy, and a clearly defined development logic (Frolov et al., 2019). They are focused on the comprehensive development of organizations and consider not only technological but also cultural and organizational aspects.

At the same time, models proposed by domestic researchers (for example, by Babkin et al.) demonstrate greater flexibility in terms of adaptation to specific enterprise conditions but require further institutionalization and standardization. The GISP digital passport, despite its widespread use, has faced criticism for its excessive detail and the high labor intensity of data collection, which reduces its effectiveness in small and medium-sized enterprises.

The applicability of models for strategic management purposes deserves special attention. Thus, foreign methodologies suggest using assessment results in formulating investment strategies, developing transformation

roadmaps, and adjusting cost structures. Domestic approaches, by contrast, are more often used for diagnostics and ongoing monitoring, not always moving into management planning.

Thus, a comparative analysis confirms the feasibility of searching for a hybrid model that combines:

- the detail and scope of a digital passport;
- the strategic focus of CMMI and Industry 4.0 models;
- the adaptability of proprietary domestic approaches;
- the visualization and managerial applicability inherent in SIRI.

The transition to such models requires the development of a unified set of indicators based on the principles of comparability, reproducibility, and independent verification. This will allow digital maturity assessment to be integrated into the strategic planning of enterprises and industry development.

It's worth noting that when implementing digital technologies, an enterprise changes existing management models, reformatting communications, technologies, and organizational structure. Therefore, the authors believe it is justified and necessary to study the formation of a development mechanism for an industrial enterprise, taking into account the changes that digital technologies bring to its operations. When developing a development mechanism for an industrial enterprise in the context of digitalization, the following tasks must be addressed (Shandova, 2014):

- Assess the current state of the enterprise and identify areas requiring improvement;
- Define the goals and objectives of the mechanism;
- Identify and describe the factors influencing it and the risks associated with its operation;
- Develop a strategy for implementing digital solutions;
- Determine the methods and tools for the development mechanism;
- Determine the outcome and develop a results monitoring system.

7. Components of the Development Mechanism

7.1. Objectives and Management

The implementation of digital technologies leads to increased operational efficiency at an industrial enterprise, namely: increased labor productivity; reduced manufacturing lead times; development of new activities; improved product quality; reduced costs; increased competitiveness; and increased research intensity.

It should be noted that not all enterprises achieve the above effects, and the results largely depend on management. An industrial enterprise is a generator of innovation, technological processes, and scientific potential in its daily operations, requiring the constant investment of financial resources. By implementing digital solutions, management alters existing processes, management models, and reformats communications, technologies, and the organizational structure, risking failure to achieve the desired results.

7.2. Transformation Areas

Human Resources, Project Teams, and Personnel

When implementing digital technologies, management must carefully form internal project teams that, together with the contractor, will begin implementing the digitalization strategy and transform the project into an operating asset. It is also important to consider the role of personnel not involved in the project. Management must also assess risks, such as employee disapproval, reluctance to adapt, and skepticism toward change. It is necessary to develop a system for motivating and engaging staff and project teams, as well as rewarding digital talent.

Organizational Structure

As the digital strategy is implemented, the company's organizational structure is also transformed. Digital transformation requires the implementation of software products, the development of business processes within software, the development of plans for further technological development, and the search for suppliers in the digital technology and services market. Management, therefore, requires a new division (a digital transformation center) and a digital transformation director. This division is functionally divided into two parts: hardware support and software maintenance. They are directly involved in developing the digital development strategy and implementing digital solutions.

Information Base, Regulatory, and Reference Information

One of the fundamental management objectives is the creation and development of regulatory and reference information (RRI), such as technological processes, product groups, regulations, and rules for creating product lists, department and contractor directories, etc. To effectively work with big data and create reliable predictive models based on it, and to utilize artificial intelligence, it is essential that RRI be unified, accurate, and synchronized across all departments and software products. The enterprise's management center must include the development of this management objective at the initial stage of the strategy before implementing any digital solution. The correctness of management decisions depends on the integrity and accuracy of the information.

Financial Base and Cost Structure

The enterprise must finance the implementation of digital technologies. Funding sources must also be identified as part of the implementation of any project. The cost structure also changes during the transformation process. Research and development, acquisition of fixed assets, intangible assets, and third-party services now occupy a special place among cost elements. Management must create project budgets, calculate the effectiveness of their implementation, and account for the process of writing off costs to cost.

Contractor Relations

A distinctive feature of digitalization as it applies to enterprises is the openness and diversity of development trajectories. Not only are enterprises transformed, but also their relationships with suppliers, customers, and other partners. The interactions between them are complex and multifaceted, so a network approach is appropriate and most effective in this case. This interaction is based on horizontal integration between enterprises, which represents a unified information space and entails the widespread exchange of information, products, and technologies. Thus, enterprises embrace innovation, improve product quality, and enhance service, thereby enhancing competitiveness.

Marketing

In addition to the transformation of enterprise interactions, changes in marketing and product promotion strategies are inevitable. In this case, it is important to note the active reorientation and application of digital marketing. This includes testing advertising platforms, traffic promotion, corporate image management, and more. Within the digital marketing system, web analytics should be noted as the source of all marketing information, from information about website visitors to online product sales.

7.3. Methods and Tools

All development methods should be divided into information technology, social, and economic.

Information technology methods within an enterprise's development mechanism represent a set of tools and techniques that optimize production, improve technologies and standards, facilitate information exchange, and enhance the level of scientific and technological progress within the enterprise. This complex consists of the enterprise's scientific personnel, interaction with scientific organizations, automated equipment, and a range of interconnected and integrated software products, which generate a wealth of information.

By social methods, we mean a set of techniques and tools that influence the emotional climate, satisfaction, and moral motivation of the team. Such methods include social planning, moral motivation, and psychological and qualification analysis. In the context of digitalization of the economy, the use of socially oriented methods is particularly important, as the effectiveness of digital solution implementation depends on the readiness and qualifications of personnel.

Economic methods, in our view, represent a set of tools and techniques that enable the analysis, planning, and control of enterprise activities. The main methods include technical and economic planning and forecasting. In other words, developing an enterprise action plan based on goals and desired results. The result of this method is a consolidated plan for all areas of the enterprise's activities, reflecting costs and results, as well as planned indicators for the enterprise's development mechanism. As a result of the digitalization of production, data becomes more accurate and transparent, enabling online monitoring of plan execution and factor analysis of results.

Characteristic features of all these methods are their interaction and interdependence. An acceptable combination of all these methods will achieve a synergistic effect, and such a mechanism for enterprise development is the most effective. It is necessary to define a list of tools as a technology for implementing actions applicable to the digital transformation of an industrial enterprise.

In this regard, we will categorize existing tools based on their role in implementing the enterprise development mechanism in the context of digitalization of the economy. In this regard, we believe it is necessary to highlight a number of tools:

– Technological tools for increasing efficiency (digitalization components, software products);

– Management tools that facilitate the achievement of goals and the effective development of the enterprise (projects, plans, strategies, methodologies);

– Tools that facilitate the development of human resources (experience exchange, retraining, training);

– Regulatory and legislative tools (reduced tax rates, state subsidies and incentives, quality standards, etc.).

In the context of digital transformation, industrial enterprise management must develop a strategy for implementing digital solutions. In a study on the implementation of digital solutions by industrial enterprises, the authors noted that this toolkit should contain a methodological framework, including an analysis of readiness for implementation, goals, stages, budget, and the economic impact of its implementation (Frolov et al., 2019). We propose the following stages for developing a strategy for implementing digital solutions:

– analysis of readiness for the implementation of digital technologies, an audit of infrastructure and software;

– analysis of business processes and identification of priority development areas;

– technology market research, analysis of proposals, and compilation of a list of digital solutions;

– methodological assessment and selection of priority digital solutions;

– development of a digitalization roadmap and a draft of the expected business model;

– strategy approval.

7.4. Internal and External Factors

It should be noted that the areas of transformation, tools, management, goals, and other elements of the mechanism described above are reflected in the block of external and internal factors. The quality of internal factors determines the effectiveness of the enterprise as a whole. Internal factors are subject to the direct influence of management; their ability to be measured, analyzed, and adjusted is higher than that of external factors. External environmental factors, such as the market, political situation, and others, have a strong external influence on enterprises. It's worth noting that the impact of the epidemiological situation currently outweighs other external

factors. Due to the COVID-19 pandemic, businesses are forced to shift to online information exchange and can also take advantage of benefits, reduced tax rates, and other government support tools. Businesses must quickly transform and adapt to external conditions. Remote workstations, flexible schedules, internal task forces, and pandemic safety tools are particularly relevant during the pandemic. Digitalization components are particularly relevant now as a means of effectively facilitating business interaction with the external environment. It's worth noting that with the implementation of digitalization components, the impact of external factors increases, while the outcome directly depends on the quality and readiness of internal factors.

7.5. Risks and Opportunities of Digital Transformation

The risks and opportunities arising during and as a result of the implementation of digital solutions, in our opinion, deserve special attention. The "Risks" section is an important information block that must be reviewed, along with the development of a risk prevention system and the calculation of its impact on the enterprise's development mechanism. One study identified the following key risks (Trachuk & Linder, 2020):

1. problems associated with the implementation of Industry 4.0 technologies themselves;

2. data security;

3. a lack of market demand to create a solution (software product) within the Industry 4.0 framework (Trachuk & Linder, 2020).

The "opportunities" block is not a component of the mechanism, but complements and clarifies the goals and results.

As a result of the implementation of digital technologies, enterprises are changing not only their business processes but also their entire business model. New activities (3D in powder metallurgy) and services using digital technologies (verifying the accuracy of a 3D product model using an online service) are emerging. As a result, new sources of income are emerging, new markets are being developed, and diversification is occurring. The study, which examines the systemic effects of the development of complex economic systems in accordance with the "Industry 4.0" concept, included an expert survey of executives at various levels at more than 40 Russian industrial enterprises, including IT directors and managers in various functional areas. The survey period was October 2017 - May 2018. Participants answered 28 questions regarding their understanding of the Industry 4.0 strategy and the implementation of digitalization processes in industrial enterprises. The authors noted that the greatest impact (84.6%) will be achieved in the area of production optimization. The next most significant impact is expected in the area of the emergence of new business models (71.8%). In third place is an increase in end-user satisfaction (51.3%) (Trachuk & Linder, 2020).

Therefore, taking into account the above, summing up the results of the study, the following can be noted. Improving and optimizing an enterprise's business processes using digital technologies allows the enterprise to increase its efficiency not only internally but also in terms of adaptation to the external environment. Management and the quality of the strategy it develops for implementing digital solutions, as well as the coordinated interaction of all elements of the enterprise's development mechanism, are of key importance in the process of forming an enterprise's development mechanism in the context of the digitalization of the economy.

It should be noted that the development mechanism for an industrial enterprise, as a representative of complex process chains, long processing cycles, and sophisticated technological equipment, should be based not only on conventional models and experience, but also on scientific methods. The design of this highly complex mechanism should be entrusted to methodologists with a thorough understanding of the conceptual components of the processes, methodology, technical capabilities, and the desired outcome.

8. Conclusion

Thus, the study proposed a system of key elements for an industrial enterprise development mechanism in the context of digitalization. It should be noted that the industrial enterprise development mechanism can be viewed in a narrow sense as a set of organizational and economic measures to improve enterprise efficiency and in a

broader sense as a form of organizing the interaction of enterprises as market participants, organizational structures, and business processes, as well as the methods and tools for implementing this interaction. Examining the industrial enterprise development mechanism through the lens of digital technologies allows us to conclude that management and the quality of the digital solution implementation strategy it develops, as well as the coordinated interaction of all elements of the enterprise development mechanism, are of key importance in the process of developing a development mechanism in the context of digitalization.

Developing a development mechanism for an industrial enterprise in the context of digitalization is a comprehensive process of integrating digital technologies (IoT, Big Data, AI, cloud) across all management levels (from operational to strategic) to create a unified system, improve efficiency, optimize processes, and free personnel from routine tasks to solve more complex problems, turning data into a key production factor and the foundation for sustainable growth. Key components of the mechanism:

1. Integration of digital systems: Creating a unified information space that unites production equipment, management, personnel, and safety.

2. Leveraging advanced technologies: Implementing IoT (Internet of Things) for equipment connectivity, Big Data for data analysis, AI (Artificial Intelligence) for decision making, machine learning for optimization, and cloud computing.

3. Digital transformation of processes: Transforming all operations into electronic form, automating routine tasks, creating digital twins and prototypes.

4. Management modernization: Using digital tools to increase productivity and improve production management flexibility.

5. Personnel Development: Retraining employees to work with new technologies, transitioning them to analytical work instead of monotonous labor.

Mechanism Development Stages:

1. Audit and Strategy: Assessing the current state, defining digitalization goals, and developing a roadmap.

2. Selecting and Implementing Technologies: Gradually equipping production with sensors, servers, and software (ERP, MES).

3. Data Integration: Creating a centralized platform for collecting and analyzing information.

4. Training and Adaptation: Training personnel, changing the corporate culture.

5. Scaling and Optimization: Expanding digital solutions, continuously monitoring and improving efficiency.

Increased competitiveness, reduced costs, accelerated decision-making, and the creation of flexible, adaptive production are ready for the challenges of the digital economy.

Thus, the digitalization of industrial production fundamentally transforms its organization, increasing the level of integration, flexibility, analytical support for decision-making, and interaction with the enterprise ecosystem. Key characteristics of industrial production organization in the context of digitalization are: integration and connectivity, flexibility and adaptability, automation and robotics, big data analytics, modeling and digital twins, remote monitoring and management, and interorganizational cooperation. Deep integration and connectivity of various information systems and technologies within an enterprise enable end-to-end digital communication between production, logistics, service, and other processes. Flexibility and adaptability are characterized by the ability to quickly reconfigure production to meet changing market demands and the use of modular, scalable production systems. Automation and robotics involve the widespread use of industrial robots, machine vision systems, automated warehouses, and the implementation of intelligent production process control systems. Modeling and digital twins involve the creation of virtual models (digital twins) of production assets and processes, enabling the rapid simulation and testing of various production scenarios.

Author Contributions

Both authors approved the final manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

Funding

This study received no external funding.

Acknowledgment

The authors would like to express their sincere gratitude to Western Caspian University for their support.

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