

## LOGISTICS INFRASTRUCTURE MANAGEMENT IN THE SYSTEM OF DIGITAL TRANSFORMATION OF THE ECONOMY OF UKRAINE

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**Abstract:** The article examines the main aspects of the digitalization of logistics processes in the context of their impact on the efficiency and competitiveness of enterprises. It explores technological innovations such as the use of big data, the Internet of Things, and blockchain, which are changing approaches to supply chain management. The role of government policy in supporting digital logistics initiatives is analyzed, and the industry's key challenges are identified. The main directions for implementing digital innovations in global logistics networks have been determined. Factors that negatively affect the implementation of digital solutions in the activities of logistics enterprises are considered. The necessity of implementing digital technologies to optimize logistics processes and increase the stability of Ukraine's economy in the face of global changes has been proven.

**Keywords:** logistics; logistics infrastructure; national economy; digitalization of the economy; sea transport; land transport; logistics infrastructure management; digital transformation.

### 1 Introduction

In today's conditions of increased globalization and the challenges caused by the destructive impact of war, the economy of Ukraine faces numerous problems. One of the most critical issues is the need to ensure the efficiency of logistics infrastructure management. To remain competitive in international markets, Ukrainian enterprises must increase their productivity and competitiveness, which is functionally impossible without modernizing logistics systems. Implementing digital technologies in logistics opens new opportunities for optimizing business processes, reducing production costs, and increasing the speed of goods delivery. However, several obstacles and barriers to complete digitalization require careful analysis and resolution.

One of the main problems today is the insufficient development of digital infrastructure in Ukraine. Despite significant achievements in financial services and payment systems, many enterprises still use outdated technologies and management methods. This limits their ability to integrate effectively into global supply chains and quickly adapt to changing market conditions. Additionally, the lack of adequate funding, a robust technical base, and qualified personnel, exacerbated by the conditions of war, are further obstacles to the digital transformation of logistics.

Integrating digital technologies in logistics requires significant investments and changes in the organizational structure of business entities. Practice shows that this can cause resistance from management and employees who fear changes and possible job cuts. It is also necessary to ensure an appropriate level of cybersecurity, as the constant growth of digital data and the digital integration of society create new risks for information security. Successful digital transformation requires state support aimed at creating favorable conditions for introducing the latest technologies in the logistics sector. This involves developing and implementing state programs to modernize infrastructure, stimulate investment, and develop human capital. International cooperation focused on Ukraine's integration into global logistics networks is also essential.

A significant problem is the uneven development of logistics infrastructure in different regions of Ukraine. This disparity in access to modern logistics services limits opportunities for enterprises located in less developed regions. Addressing this issue requires a comprehensive state strategy that considers regional characteristics and promotes the uniform development of logistics networks throughout the country.

Considering the aforementioned problems, there is an objective need to study approaches to improving the current state of logistics infrastructure in Ukraine in the context of its digital transformation. This will help formulate recommendations for enhancing its efficiency.

### 2 Literature Review

The study of logistics infrastructure management in the context of digital transformation addresses a wide range of scientific problems, reflecting the current state and prospects for developing logistics systems amid digitalization. Much work currently focuses on using digital technologies to optimize logistics processes and their impact on the economic efficiency of enterprises.

First, it is essential to note the research by both domestic and foreign scientists who emphasize the importance of digital transformation for the development of logistics and the effective functioning of enterprises. Notably, the works of I. Britchenko [2-11], T. Kulinich [21-23], O. Ramos [26], J. Reitšpís [27], and I. Zrybneva [34] highlight that the introduction of the Internet of Things (IoT), big data, and blockchain technologies significantly increases the transparency and efficiency of supply chains. These technologies enable effective, accurate monitoring and real-time resource management, which helps reduce costs and improve the quality of customer service.

Additionally, the works of I. Arutiunian [1], Y. Danshina [12], M. Masl'an [25], M. Rudenko [29], and A. Zielińska [33] focus on analyzing the economic benefits of digitalizing logistics processes. Studies show that using digital platforms for supply chain management reduces delivery time and optimizes inventory and transportation costs. Furthermore, implementing automated systems for managing warehouse processes enhances accounting accuracy and reduces enterprise losses. Digitalization allows enterprises to respond more quickly to market changes and implement innovative solutions.

Considerable attention is also given to the role of government policy in supporting the digital transformation of logistics. Research by M. Dziamulych [13-20], T. Shmatkovska [30], and V. Zhuk [32] emphasizes the need to create favorable conditions for investments in developing digital infrastructure, primarily through state programs and stimulating the private sector to adopt the latest technologies.

Based on the analysis of existing scientific developments in the digital transformation of logistics infrastructure, there is a clear need to enhance its efficiency and competitiveness. Therefore, continued research in this area is necessary to determine optimal approaches for integrating digital technologies into logistics processes successfully.

### 3 Materials and Methods

In researching the specifics of logistics infrastructure management within Ukraine's digital transformation system, a suite of unique scientific methods was employed, enabling a comprehensive analysis of the problem and the formulation of practical recommendations.

A comparative analysis was conducted to study the current state of logistics infrastructure in Ukraine, contrasting it with systems

in other countries. This approach identified the strengths and weaknesses of Ukrainian logistics and suggested improvement methods adaptable to Ukrainian conditions.

The abstract method was utilized to generalize theoretical concepts and develop an overarching understanding of logistics infrastructure management in the context of digitalization. This method facilitated the study of the main principles of digital logistics, highlighting key elements and their functional relationships. It enabled the investigation of the interactions among various components of the logistics system under digital transformation conditions.

The inductive method was employed to derive general conclusions from the analysis of digitalization processes at the level of individual enterprises and industries. This method allowed the identification of general trends and patterns characteristic of the digital transformation of logistics in Ukraine.

The logical generalization method was used to systematize the obtained data and formulate overarching recommendations. This method involved classifying and summarizing the identified problems, enabling the proposal of strategies to address them. Additionally, the logical generalization method helped develop a holistic concept for managing logistics infrastructure amid the digital transformation of Ukraine's economy.

The research drew on scientific publications, official statistical data, analytical reports, and materials from open sources related to the digital transformation of logistics.

#### 4 Results and Discussion

In the context of the intensifying technological development of the global economy, the digitalization of logistics processes significantly impacts the efficiency and competitiveness of business entities. The introduction of digital technologies enables substantial optimization of supply chain management, enhancing transparency and accuracy. This optimization helps reduce costs and increase the speed of goods delivery to end consumers. An essential aspect of digitalization is integrating digital platforms for managing logistics operations. These platforms provide centralized management and control over all stages of the logistics process, from ordering to product delivery. This significantly reduces the time needed to perform operational tasks and improves communication effectiveness between various supply chain participants, facilitating the quick identification and resolution of existing problems.

The use of digital solutions in enterprise management is also crucial, as they enhance analytics and forecasting capabilities. Innovative analytical tools enable enterprises to better understand market and customer needs, optimizing stock levels and avoiding excessive costs. Additionally, these tools support more informed decision-making regarding the expansion or reduction of logistics capacities based on current market trends. Accordingly, digital technologies improve customer interaction and satisfaction, a critical marketing requirement. Modern systems offer transparency in tracking goods delivery, reducing the risk of losses and increasing customer confidence. Moreover, digitalization allows for a more flexible and personalized approach to service, an essential competitive factor in contemporary conditions.

Overall, the digitalization of logistics processes creates new opportunities to increase the efficiency and competitiveness of business entities. It not only improves service quality but also promotes accelerated adaptation to changing market conditions and reduces operating costs. Therefore, in the digital economy, such transformations are necessary to ensure the sustainable development of enterprises.

It should be noted that in Ukraine, the war has significantly changed logistics business processes, directly affecting the management and operational functioning of the logistics infrastructure. The main transformations have occurred in the

warehouse operations sector, driven by the need to accelerate goods sales due to the threat of loss from military actions and increasing delivery and staffing challenges. The main factors leading to the transformation of logistics business processes are defined in Table 1.

Table 1: The main factors that influenced the transformation of logistics business processes in Ukraine after the start of the war

Factor	Impact on business processes
Rejection of storage and accumulation of goods	Goods that could previously be in the warehouse for a long time were tried to be sold immediately in order to minimize the accumulation of leftovers in order to avoid product losses in the event of an attack on the warehouse
Sharp and rapid changes in warehouse conditions	Companies were forced to completely move their warehouses in a few weeks or even a few days. Despite the fact that it usually takes about 3 months to start a warehouse. It includes moving the warehouse, setting up video surveillance and security, creating an IT system and its integration. Despite such difficult conditions, companies were able to move from dangerous areas and continue to work
Complication of logistics operations	Due to the large number of inspections, roadblocks and the introduction of a curfew, the transportation of all goods, including food products, was disrupted

Source: [28]

Enhancing the efficiency of transport and logistics infrastructure management through the introduction of digital business models is a viable solution. Digital technologies optimize logistics processes, leading to a reduction in operating costs and an overall improvement in resource management. This, in turn, addresses problems in operational logistics and warehouse management. Digital software solutions facilitate rapid responses to market changes and provide more accurate forecasting and logistics planning. In the context of globalization, this is crucial for maintaining and expanding market positions both nationally and internationally.

Moreover, the digitization of business models in the transport and logistics industry enhances transportation safety and supply reliability, which is vital for the modern Ukrainian economy. The integration of digital systems allows for better real-time cargo tracking and quicker problem detection and resolution, reducing the risks of delays and losses. Additionally, digital technologies enable effective interaction among all logistics chain participants, ensuring high coordination and increasing overall productivity. Therefore, digitalization is essential for achieving sustainable development in today's highly competitive business environment.

Regarding the current application of digital software and management solutions in logistics systems, the best prospects for the next five years include digital solutions that incorporate artificial intelligence for route optimization and inventory management, cloud technologies for real-time data access and process automation, and digital platforms for integrating and coordinating supply chain participants. Furthermore, there are significant opportunities for using drones and autonomous vehicles for delivery, which will substantially increase the efficiency and speed of logistics operations.

According to experts, the planning and implementation level of digital technologies in logistics infrastructure is relatively high. Innovative approaches reduce operating costs across all supply chain components, leading to increased profitability for logistics enterprises. Simultaneously, the level of implementation of digital innovations in leading global market companies is relatively high (Figure 1).

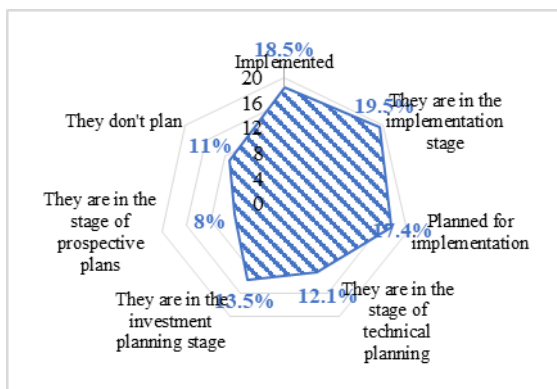


Figure 1. Readiness to implement digital innovations in global logistics networks

Source: [31]

A high level of digital technology implementation in the global logistics sector demonstrates that innovative solutions are fundamentally transforming supply chain management, making it more integrated, transparent, and efficient. Artificial intelligence and machine learning enable businesses to more accurately forecast demand and optimize inventory, reducing costs and preventing shortages. Cloud technologies provide instant access to real-time data, facilitating prompt decision-making and quick responses to market changes. Drone delivery and autonomous vehicles enhance delivery speed and reliability, minimizing human errors. Integrating digital platforms to coordinate all supply chain participants improves the coherence of actions and the effectiveness of cooperation. Consequently, digitalization optimizes operational processes and enhances the overall productivity, competitiveness, and adaptability of logistics enterprises to dynamic market changes (Table 2).

Table 2: Directions of application of digital innovative solutions for solving logistics tasks

Technological solutions	Logistics tasks
Unmanned transport systems	<ul style="list-style-type: none"> <li>– reducing the workload on warehouse staff;</li> <li>– reducing the number of errors in internal transport processes</li> </ul>
System of digital doubles	<ul style="list-style-type: none"> <li>– forecasting with a much higher degree of reliability of the state of the object, as well as tracking its state in real time;</li> <li>– in-depth understanding of the processes taking place in the object, due to the development of statistics of "virtual" operation;</li> <li>– more accurate calculation of project economics;</li> <li>– identification of weak parts of the system and subsequent elimination of their shortcomings</li> </ul>
Data processing tools based on artificial intelligence	<ul style="list-style-type: none"> <li>– distribution of orders by machines and construction of optimal routes;</li> <li>– forecasting traffic jams</li> </ul>
Blockchain	<ul style="list-style-type: none"> <li>– increasing the reliability and transparency of the supply chain;</li> <li>– prevention of discrepancies in documentation.</li> </ul>
Internet of things	<ul style="list-style-type: none"> <li>– connecting transport to the Internet: transparency of the entire length of supply chains; traffic mode control; increasing discipline;</li> <li>– ensuring safety: prevention of improper operation of transport; easy access to data to investigate events;</li> <li>– asset monitoring: tracking the movement and displacement of cargo; instant description of cargo in container,</li> </ul>

	warehouse, etc.; – access to the location of cargo along the entire transportation route
Robotic automation of operational processes	<ul style="list-style-type: none"> <li>– automation of repetitive, standardized processes with a small number of well-defined solutions;</li> <li>– customer satisfaction and improved service quality;</li> <li>– reduction of personnel training costs;</li> <li>– work online without stopping the production process;</li> <li>– integration with existing systems.</li> </ul>

Source: [34]

It is also worth noting that in the context of globalization and labor specialization, some digitalization functions may be less productive within the enterprise itself. In such cases, it is beneficial to consider the market, where specialist companies offer similar services at competitive prices and higher quality. Outsourcing opens up prospects for enterprises to increase the efficiency of their logistics processes. According to experts in the field of logistics, innovative technological solutions are currently being applied in areas such as autonomous transport systems, digital twins, artificial intelligence, blockchain, the Internet of Things, and robotic process automation.

However, the practical implementation of digital solutions in logistics processes faces objective obstacles, including organizational challenges and dynamic changes in market requirements, often necessitating drastic adjustments in the application of new technologies. In particular, a survey of managers from transport and logistics enterprises (allowing up to three answers) identified the main factors that negatively affected the implementation of digital solutions in their activities (Figure 2).

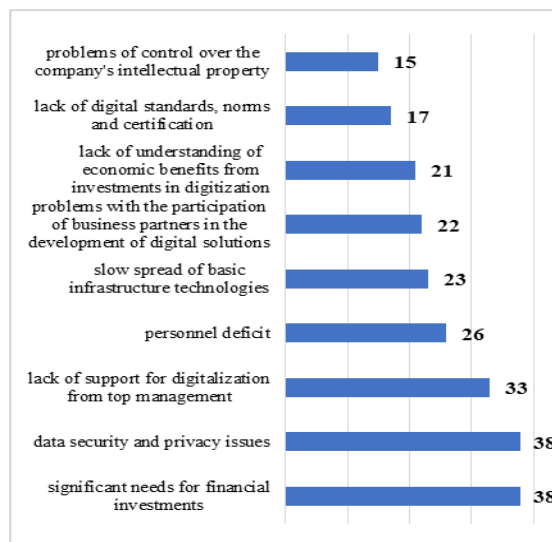


Figure 2. Factors that negatively affect the implementation of digital solutions in the activities of logistics enterprises of Ukraine, %

Source: [31]

To ensure the effective digital transformation of the logistics sector, it is essential to provide not only market incentives for enterprises to implement digital solutions in logistics business processes but also to establish state policies that support digital initiatives. Such policies can create favorable conditions for their implementation and development. Additionally, the state can directly contribute to the development of digital infrastructure through targeted investments in modern technologies and telecommunications networks. This includes expanding access to high-speed internet and ensuring reliable coverage in all regions, which forms the foundation for the effective operation of digital logistics systems.

State support should involve the development and implementation of regulatory norms that stimulate innovation and the adoption of digital technologies in the logistics sector. This can be achieved by creating a legal framework for new technologies, such as autonomous vehicles and drones, and by standardizing data and processes in logistics to facilitate the integration and interoperability of different innovative systems.

Furthermore, providing financial incentives through tax benefits and grants for enterprises investing in the digitization of operational processes is crucial. Such incentives can lower financial barriers for small and medium-sized businesses, encouraging them to adopt advanced technologies. In addition, as digital software solutions become increasingly complex, training qualified personnel is critical for the successful digital transformation of the logistics sector. This necessitates the implementation of specialized educational programs and initiatives. State support in this area is most effective when it includes funding training programs and establishing specialized training centers through public-private partnerships.

Overall, state policy plays a crucial role in creating a conducive environment for the digitalization of logistics, enhancing the efficiency, competitiveness, and sustainability of the Ukrainian economy amid global digital transformation. Adequate government support can facilitate coordination across different economic sectors, promoting a more integrated implementation of digital technologies in logistics. Additionally, the state's regulatory role in ensuring cybersecurity and data protection is vital, as these are critical aspects of modern digitalization.

## 5 Conclusion

Thus, we conclude that digitalization in logistics is a means of enhancing the competitiveness of enterprises and reducing operating costs through the optimization of inventory management. The analysis indicates that the adoption of digital technologies in logistics processes is a crucial factor for optimizing supply chains and improving customer service quality. A key aspect in this context is the establishment of a robust digital infrastructure that ensures rapid and uninterrupted real-time access to information, thereby facilitating informed management decisions.

Successful digitalization requires substantial state support, including investments in technology development, incentives for the private sector to adopt innovations, and the establishment of a favorable regulatory environment. Additionally, training qualified personnel proficient in the latest technologies and their practical application in logistics processes is essential. Therefore, it is recommended to integrate advanced digital solutions into enterprise practices, such as the automation of logistics processes, big data analytics, artificial intelligence, and other innovations that enhance demand forecasting accuracy, optimize inventory, and reduce operating costs. These measures will contribute to minimizing risks, improving the efficiency of interactions among supply chain participants, and enhancing the transparency of logistics operations at all stages.

It can be argued that digitalizing logistics infrastructure is vital for increasing Ukraine's economic stability. The implementation of modern technologies will enable Ukrainian enterprises to rapidly adapt to market conditions and ensure long-term stable development. This, in turn, will bolster the country's economic security and attractiveness to investors, creating new opportunities for growth and innovation.

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