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AD ALTA: JOURNAL OF INTERDISCIPLINARY RESEARCH USES THE RIV BRANCH GROUPS AND BRANCHES, BUT THE JOURNAL IS NOT A PART OF RIV. THE RIV IS ONE OF PARTS OF THE R&D INFORMATION SYSTEM. THE RIV HAS COLLECTED AN INFORMATION ABOUT RESULTS OF R&D LONG-TERM INTENTIONS AND R&D PROJECTS SUPPORTED BY DIFFERENT STATE AND OTHER PUBLIC BUDGETS, ACCORDING TO THE R&D ACT [CODE NUMBER 130/2002], THE CZECH REPUBLIC.

A SOCIAL SCIENCES
B PHYSICS AND MATHEMATICS
C CHEMISTRY
D EARTH SCIENCE
E BIOLOGICAL SCIENCES
F MEDICAL SCIENCES
G AGRICULTURE
I INFORMATICS
J INDUSTRY
K MILITARISM

TABLE OF CONTENTS (BY BRANCH GROUPS)

A SOCIAL SCIENCES

F MEDICAL SCIENCES

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

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Abstract: The article examines the features of the digital transformation of Ukraine's economy and its impact on logistics infrastructure management, focusing on increasing the efficiency of logistics operations, reducing costs, and enhancing the competitiveness of enterprises. The main aspects of logistics infrastructure management in the digital economy are studied, particularly the introduction of modern digital technologies such as automation, the Internet of Things, blockchain, and big data analytics. Approaches to integrating digital solutions into logistics processes, modernizing transport and warehouse systems, and developing intelligent transport networks are considered. The need for cooperation between the public and private sectors to create optimal conditions for the operation of the logistics infrastructure is determined. The main problems and prospects of implementing digital technologies in logistics are clarified, and recommendations are offered for optimizing processes and increasing the digital maturity level of Ukraine's logistics infrastructure to ensure sustainable economic development.

Keywords: logistics; logistics infrastructure; logistics management; service facilities; digital transformation; digital technologies; sustainable development; business model.

1 Introduction

Logistics infrastructure management in Ukraine's digital transformation is one of the critical issues affecting the country's competitiveness in the international market. Integrating the national economy into global economic processes necessitates modernizing logistics systems and adapting them to new digital challenges.

The main problem is the imperfection of the existing logistics infrastructure, which often does not meet modern requirements and standards. In particular, outdated technologies and processes, limited capacity of transport networks, and insufficient coordination between different modes of transport and warehouse chains lead to high costs and increased delivery times. Additionally, Ukraine's weak integration into interstate logistics systems requires priority solutions in the European integration process. These factors significantly reduce the competitiveness of Ukrainian enterprises in the global market.

It is also necessary to note the insufficient flexibility of logistics processes, which makes it challenging to adapt to rapid changes in the market and increase the efficiency of enterprises. Furthermore, the lack of a unified strategy for developing logistics infrastructure and coordinating actions between state bodies and private enterprises creates additional barriers to effectively managing logistics processes at both the macro and micro levels. An integral part of the problem is the limited financial resources and investment opportunities for modernizing logistics infrastructure. Many projects remain unrealized due to insufficient funding, which slows down the digital transformation process. This issue has significantly worsened after the Russian aggression and the start of a full-scale war, necessitating state assistance in developing infrastructure.
In this regard, there is an objective need to develop comprehensive approaches to logistics infrastructure management that consider the modern requirements and challenges of the digital economy. It is essential to create conditions for attracting investments in developing logistics networks, establishing new transport corridors, and systematically improving the professional training of specialists in logistics.

Thus, the need to form a logistics infrastructure development strategy highlights the urgency of researching innovative approaches to its management, considering the specifics of the Ukrainian economy and its future European integration. Their development will ensure the effective functioning of Ukraine's logistics system and contribute to the growth of its competitiveness and sustainable economic development.

2 Literature Review

The study of logistics infrastructure management issues in the context of digital transformation encompasses a wide range of research addressing various aspects of this topic. Existing scientific developments outline the main directions for development and identify critical problems and prospects in this field.

Fundamental studies on this problem, focusing on the general principles and methods of logistics systems management, are highlighted in the works of authors such as N. Antoniuk [1], N. Khomiuk [22], T. Shmatkovska [26-31], and others. These works define the theoretical foundations and practical aspects of applying various models of logistics management in a global context. The research emphasizes the importance of an integrated approach to managing logistics processes and the need to use modern information technologies to improve efficiency.

Significant contributions to the study of digital transformation have been made by scientists such as I. Britchenko [3-12], V. Sarioglo [25], R. Sodoma [32], A. Verzun [35], and others. Their works focus on the adaptation of logistics models to Ukrainian realities, addressing issues such as the modernization of transport corridors, improving coordination between different types of transport, and forming a unified information platform for managing logistics processes. Special attention is given to developing transport infrastructure, a critical element of the logistics system. These studies indicate the need to modernize logistics infrastructure and introduce innovative solutions in logistics management. They also highlight the importance of integrating new transport corridors connecting Ukraine with European markets, considering Ukraine's future European integration.

An essential aspect of scientific research is the role of public policy and public-private partnerships in developing logistics infrastructure. The works of I. Arakelova [2], M. Dziamulych [13-21], M. Rudenko [24], and others analyze the main directions of state policy, particularly in attracting investments, reforming the legislative framework, and supporting private initiatives in logistics. These studies indicate the need to create favorable conditions for developing logistics infrastructure through public-private partnerships.

In general, modern research shows that managing logistics infrastructure in the context of Ukraine's digital transformation is a multifaceted problem requiring a comprehensive approach and consideration of regional economic specifics. There is also a need for further research in this area to develop effective strategies for managing logistics processes to ensure the country's sustainable economic development.

3 Materials and Methods

In researching the principles of logistics infrastructure management in the context of the digital transformation of the economy, a comprehensive approach combining several

scientific analysis methods was applied. This approach allowed for the thorough examination of various aspects of the investigated problem.

The primary sources of research information included specialized scientific publications focused on logistics, logistics systems management, digital transformation of the economy, and infrastructure development; official statistical data from the State Statistics Service of Ukraine and international organizations; the legal framework of Ukraine regarding the regulation of logistics and transport; and documents related to the digital transformation of the economy.

Both general and specific methods of scientific inquiry were employed to achieve the research goals and solve the identified problems. Specifically, the analysis method was used for a detailed study of the components of logistics infrastructure, identifying its problematic aspects, and assessing the impact of digital technologies on logistics processes. The analysis of statistical data and scientific literature enabled the identification of key trends and issues in managing Ukraine's logistics infrastructure.

The comparison method was utilized to analyze logistics systems and infrastructure solutions in different countries, aiming to determine the experience of adapting logistics management models and their application in Ukraine. Comparing the efficiency indicators of logistics systems and their digital maturity helped outline the developmental direction for the Ukrainian economy.

The method of logical generalization facilitated the formulation of key conclusions and recommendations regarding logistics infrastructure management in the context of digital transformation. This method helped structure the obtained data and identify the main patterns and trends.

The expert evaluation method was used to validate the research results and gather additional information by studying the experiences of experts in logistics and digital technologies. This method accounted for the opinions of leading specialists and provided an objective assessment of the state and prospects for the development of Ukraine's logistics infrastructure.

Data collection involved analyzing scientific publications, statistical data, regulatory acts, and expert assessments. A detailed analysis of Ukraine's logistics infrastructure and its comparison with similar systems in other countries was conducted based on the collected data. The study's results were summarized to formulate conclusions and recommendations.

Thus, the application of all specified methods provided a comprehensive approach to studying logistics infrastructure management in the context of Ukraine's digital transformation, contributing to obtaining objective and scientifically based results.

4 Results and Discussion

The current digital transformation of Ukraine's economy aims to significantly change the structure and functioning of various sectors, including logistics infrastructure. This transformation is characterized by the intensive implementation of modern information and communication technologies, which enhance the efficiency, transparency, and flexibility of logistics management. A key feature of this transformation is the comprehensive adoption of digital platforms and online services, contributing to more efficient logistics process management. These technological solutions help reduce costs, optimize transportation routes, and improve inventory management within logistics systems. They also reduce order processing times and enhance overall customer service. Digitalization enables enterprises to integrate various links of the logistics chain into a unified system, ensuring transparency and increased control over all operations.

Practically, the implementation of digital solutions, such as electronic document management and digital platforms for transportation management, significantly reduces bureaucratic procedures and accelerates cargo processing in logistics. This is particularly crucial for international shipments, where the speed and accuracy of documentation are essential. Digital technologies enable Ukrainian enterprises to interact more effectively with foreign partners, enhancing their competitiveness in the global market.

A critical aspect of today's digital transformation is the implementation of real-time data-based monitoring and control systems. These systems allow for quicker responses to changes in logistics processes, the prevention of delays, and the minimization of risks. Additionally, such systems enable the analysis of large volumes of data, supporting more informed management decisions. Consequently, digital transformation fosters the development of new business models in logistics, such as platforms for sharing vehicles and warehouse space. These innovations reduce logistics costs and make processes more flexible and adaptable to market needs.

However, digital transformation presents several challenges. One of the primary challenges is the need for substantial investments in technology and infrastructure. Amid the instability caused by the ongoing war, this can pose a significant barrier for many Ukrainian enterprises. The personnel factor is also critical, as a shortage of specialists in digital technologies can slow the transformation process. Additionally, the growth of digital technologies increases the risk of cyber-attacks, which can lead to data loss and disrupt logistics systems. Therefore, it is essential to implement modern information protection measures and develop strategies for responding to cyber threats to ensure the effectiveness of digital systems.

Thus, the digital transformation of Ukraine's economy significantly impacts logistics infrastructure management, enhancing its efficiency and competitiveness. However, to achieve optimal results, Ukrainian enterprises must overcome challenges such as attracting additional infrastructure investments and ensuring the cybersecurity of logistics systems.

To assess the efficiency and effectiveness of logistics systems, consider the country’s Logistics Productivity Index (Figure 1).

As seen, Ukraine's overall LPI Index indicates it is among the countries with an average level of logistics systems and infrastructure development. However, infrastructure development and customs barriers are among the most problematic indicators, necessitating measures to improve regulatory legislation in international trade and increase investment in infrastructure projects.

Managing logistics infrastructure in the digital economy is a multifaceted process that integrates modern technologies and optimizes logistics processes to increase industry efficiency. Key aspects of such management include implementing digital technologies, integrating logistics systems, managing data, and developing innovative logistics solutions.

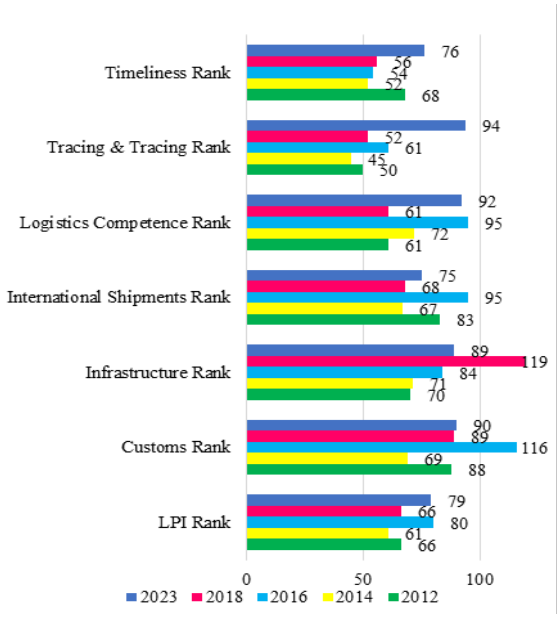

Figure 1. Dynamics of LPI Rank of Ukraine and its sub-indicators for 2012-2023.
Source: [23]

Implementing digital technologies is currently a crucial aspect of logistics infrastructure management. Technologies such as electronic document management, warehouse operations management systems (WMS), and transport management systems (TMS) help reduce costs, accelerate processes, and improve data accuracy. Additionally, digital platforms enhance the transparency and controllability of logistics operations, facilitating faster information exchange among all participants in the supply chain.

The integration of logistics systems ensures consistency and coordination between various elements of the logistics infrastructure. Integrated management systems help create a unified information environment where all processes, from ordering a product to its delivery to the end consumer, can be tracked and optimized in real time. This integration shortens order fulfillment times and reduces the risks associated with inconsistencies between different logistic links within the system.

Digital solutions in data management have shown particular effectiveness. The use of big data and analytical tools allows for detailed analysis of logistics processes, forecasting supply and demand, and identifying opportunities for optimizing supply chains. Furthermore, innovative solutions such as autonomous vehicles, drones for delivery, and robotic systems in warehouses significantly increase the productivity of logistics operations and reduce costs for enterprises.

These innovative solutions rely on the operational processing of large amounts of data regarding orders, market dynamics, and potential consumer needs. Such approaches enhance the efficiency of logistics management, reduce costs, and ensure a high level of customer service—critical success factors in the modern economic environment.

Under these conditions, the volume of investments in the country's logistics infrastructure, from both state financing and private investors, becomes vital (Figure 2).

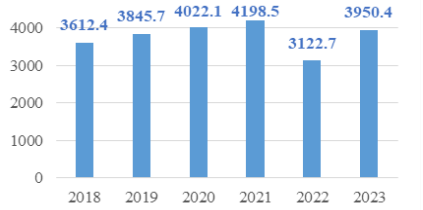

Figure 2. The dynamics of total investments in Ukraine`s logistics infrastructure for 2018-2023, UAH million.
Source: [33]

As we can see, the positive dynamics of investment growth in logistics infrastructure were significantly disrupted with the onset of the war. In 2022, investments sharply decreased from UAH 4198.5 million to 3122.7 million, a decline of 25.7%. The recovery of investment volume in 2023 is primarily due to the inflationary increase in project costs rather than an actual increase in investments. Consequently, there is a need to develop digital solutions that would enhance the efficiency of Ukraine's existing logistics infrastructure.

Specialized TMS (Transportation Management Systems) and WMS (Warehouse Management Systems) are critical digital solutions for integrating and optimizing logistics infrastructure management. These systems are fundamental components of the digital transformation of logistics infrastructure. They ensure the integration of modern technologies into logistics management, contributing to increased efficiency, accuracy, and transparency in logistics processes. They provide a comprehensive approach to managing transport and warehouse operations, significantly improving coordination and control throughout the logistics chain.

TMS automates and optimizes cargo transportation processes, which is crucial for reducing costs and increasing delivery speed. This system uses sophisticated algorithms to plan and optimize routes, considering various logistics parameters such as cost, delivery time, and road restrictions. As a result, logistics enterprises can use their transport resources more efficiently, reducing transportation costs and increasing delivery reliability. Additionally, TMS provides real-time monitoring and management of vehicles and cargo, allowing for quick responses to changes or unforeseen situations, thereby enhancing the transparency and controllability of logistics operations.

WMS automates and optimizes warehouse operations. This system provides effective inventory management, improving receiving, storing, and shipping processes. WMS tracks each product's location in real-time, facilitating fast and accurate order fulfillment. It also optimizes warehouse space and resources, reducing storage costs and increasing productivity. A critical feature of WMS is its ability to integrate with other enterprise systems, such as ERP (Enterprise Resource Planning) and TMS, ensuring seamless data exchange between different parts of the logistics chain. According to experts from the Ukrainian Logistics Alliance, implementing TMS and WMS has allowed Ukrainian enterprises to gradually increase additional profit generated by the enhanced efficiency of digital management solutions (Figure 3).

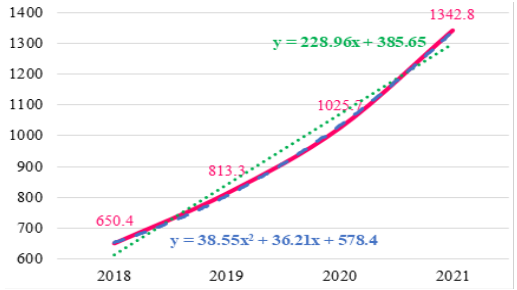

Figure 3. Profit growth of Ukrainian enterprises that have integrated TMS and WMS digital solutions into their operations for 2018-2021, UAH million.
Source: [34]

From the calculations, we observe that the parameters of the linear trend indicate a tendency for profit to grow by UAH 228.96 million, with an absolute increase of UAH 228.96 million. Additionally, the polynomial trend analysis reveals that the actual annual change in the profit of logistics enterprises amounted to UAH 36.21 million, compared to the initial growth of UAH 35.55 million.

The functional integration of TMS and WMS creates a unified information environment for managing logistics infrastructure at the enterprise level. This integration ensures consistency and coordination between transport and warehouse operations, leading to more efficient resource management and reduced logistics costs. Therefore, utilizing such integrated systems enables enterprises to adapt quickly to market conditions and changes in customer requirements, thereby increasing their market competitiveness.

One of the key advantages of using TMS and WMS is the capability to analyze large volumes of data and make informed management decisions. These systems facilitate the collection and analysis of data on all logistics processes, enabling the identification of trends and anomalies, which helps optimize operations and enhance management efficiency. Additionally, the use of TMS and WMS improves customer service by ensuring the accurate and timely fulfillment of orders, thereby increasing customer satisfaction and strengthening their trust in the company. Integration with other systems, such as CRM, allows companies to better understand customer needs and expectations, offering more personalized and practical solutions.

Thus, integrating digital solutions through TMS and WMS provides a comprehensive approach to managing logistics infrastructure, enhancing the efficiency, accuracy, and transparency of logistics processes. This integration helps reduce costs, improve customer service, and increase companies' competitiveness in the market.

5 Conclusion

Thus, we conclude that logistics infrastructure management is critical for increasing enterprises' efficiency and competitiveness during the digital transformation of Ukraine's economy. Implementing modern digital solutions, such as TMS and WMS, allows for the optimization of transport and warehouse processes, reducing costs and increasing the accuracy and speed of order fulfillment. Research shows that businesses actively using these systems experience a significant increase in profitability, confirming the effectiveness of digital innovation in logistics. Consequently, digital technologies contribute to forming integrated information systems that ensure transparency and control over all logistics operations. An important aspect is the development of big data analytics, which allows for real-time monitoring and management of logistics processes and enables informed management decisions based on detailed data analysis.

Investments in developing logistics infrastructure, which ensure the modernization of transport and warehouse systems and increase their efficiency and adaptability to modern market requirements, play a significant role in digital transformation. This relevance is heightened in wartime conditions, as enterprises strive to accelerate stock turnover and avoid excessive accumulation in warehouses.

Therefore, managing logistics infrastructure in the context of Ukraine's digital economy transformation requires a comprehensive approach that includes introducing modern technologies and increasing investments in infrastructure development. This approach will ensure sustainable economic growth and enhance the competitiveness of Ukrainian enterprises in the global market.

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