UDC 338.47:004.9:656
DOI: 10.15587/1729-4061.2025.345242

RIGOROUS ANALYSIS OF DIGITALIZATION ECONOMICS INFLUENCE ON A TRANSPORT ENTERPRISE MANAGEMENT SYSTEM

Yuliia Remyha
PhD, Associate Professor, Head of Department
Department of Management and Logistics**
Tetiana Ostapenko
Corresponding author
Doctor of Economic Sciences, Associate Professor*
E-mail: ostapenco@ukr.net
Tetiana Posnova
PhD, Associate Professor*
Oleksandr Ponomarov
PhD, Associate Professor
Department of Economics and Business Technologies***
Denys Shcherbatykh
PhD, Associate Professor, Head of Department*
Iryna Hrashchenko
PhD, Associate Professor
Department of Management of Foreign Economic Activity of Enterprises***
*Department of Economics, Finance and Accounting**
**European University
Volodymyr Vernadskiy ave., 16B, Kyiv, Ukraine, 03115
***State University "Kyiv Aviation Institute"
Lyubomyra Huzara ave., 1, Kyiv, Ukraine, 03058

This study investigates approaches to the formation of the digital economy and their impact on the management system at a transportation enterprise. Under martial law, transportation becomes a means of implementing production relations in the economic environment. Transportation of goods and passengers by land transport is an element of the activation of the economic system, the digitalization of which is a lever for modernizing productive forces and relevant production relations. The task addressed is related to determining the impact of digital technologies on the management system at a transport enterprise.

Studying the economics of digitalization makes it possible to identify the accents and components of the management system at various enterprises, and transport enterprises in particular. Such research is necessary to outline the conditions for management improvements and the economic system of digitalization of the transport industry. Understanding the directions of using digitalization is useful in modernizing the managerial and economic levers of influence on profit. Such directions are the use of artificial intelligence, information technologies, telecommunications gadgets, social media, and various applications, as well as electronic document management. These levers are actively used in the activities of transport companies. Thus, the current study is aimed at identifying the most indicative directions in digitalization to understand their nature and the consequences of their application in the practice of transport enterprises.

Conclusions from the study make it possible to understand the essence of the digital economy and the conditions for its use in the formation of various types of systems, including management systems. An enterprise was chosen as an example, on the basis of which a multifactor regression analysis was conducted. The results of this analysis highlight the conclusion that digitalization does not actively affect the profitability of the enterprise and is a factor that indirectly provides the company's income

Keywords: digitalization, digital technologies, artificial intelligence, management system, transport industry

Received 03.09.2025
Received in revised form 06.11.2025
Accepted 13.11.2025
Published 30.12.2025

How to Cite: *Remyha, Y., Ostapenko, T., Posnova, T., Ponomarov, O., Shcherbatykh, D., Hrashchenko, I. (2025). Rigorous analysis of digitalization economics influence on a transport enterprise management system. Eastern-European Journal of Enterprise Technologies, 6 (13 (138)), 31–45. https://doi.org/10.15587/1729-4061.2025.345242*

1. Introduction

The evolution of the world economy largely depends on the state of international trade and other relations; this highlights the central role of transport, which ensures the uninterrupted movement of goods, passengers, baggage, and mail. The pace of transport development was so high that the achieved changes can be compared in scale with the progress over the entire previous history of the growth of the industry. The rapid technological progress that began in the mid-twentieth century and went down in history as the "transport revolution" was of decisive importance for the development of modern transport. Within the framework of the latter, the "container revolution" was defined as a separate, special phenomenon, which served as a certain starting point for the further accelerated progress of all types of transport. The nature and essence of technologies have also changed significantly: from industrial to digital. And whereas containers have changed the content of transport, digitalization changes the content of the transport service itself.

There are processes of facilitating and reducing the cost of all links in the process of delivering general cargo from the manufacturer to the consumer. Delivery times have been reduced, and cargo safety has improved, which has also contributed to a decrease in the price of industrial products. The use of special gadgets that track cargo and their location in

the warehouse has simplified logistics operations. The use of special software has made it possible to automate logistics operations and simplify their use at transport enterprises.

The management system of a transport enterprise can also be digitalized. Approaches to digitalization are different for different management functions. Thus, most planning processes are carried out with the active participation of artificial intelligence (AI). The organizational function also involves the use of information technology (IT) to determine the organizational structure of the enterprise and establish connections between different departments. The implementation of the motivational function, especially material incentives, also involves the use of applications that calculate the size of bonuses and premiums. Coordination, as a management function, can be digitalized by using special document flow between individual employees of the company. The control function is also subject to digitalization as tracking the compliance of plans with the results of activities.

Thus, the relevance of this research area is predetermined by the fact that in the era of the development of digital systems at transport enterprises it is necessary to form a management system that would allow them to be mobile and perform all management functions in the domain of digital technologies.

2. Literature review and problem statement

Study [1] highlights the aspects of the formation of a national digital policy and the strategic framework for artificial intelligence in a security economic system. The directions of digitalization and its limits for monitoring the security framework are determined when the qualitative indicators of digitalization should be aimed at protecting business entities and not harming them. However, issues related to the development of the directions of influence of digital technologies on the management system of a transport enterprise remain unresolved. An option for overcoming the relevant difficulties may be the development of directions for optimizing digital solutions at transport enterprises.

Work [2] defines the process of managing the information potential of an energy enterprise and forming a model of its digital behavior. Issues of digital risks are highlighted that have a certain impact on the management and productive indicators of the activities of specific enterprises. Technologies and processes that may depend on the digitization of economic phenomena are determined. In addition, the issues of strategic and operational governance based on digital approaches at energy sector enterprises are outlined. The aspects of the impact of digital risks on Ukrainian enterprises in various industrial sectors are unresolved. The solution to this situation has the following basis: it is fundamentally impossible to single out the directions of digitalization and determine them statistically.

Paper [3] examines the features of innovative approaches to project financial management in the context of digitalization. These aspects are considered as factors for increasing the efficiency of decision-making and improving the competitive advantages of specific enterprises. The advantages and disadvantages of digitalization of project management are highlighted. A forecast for the use of digital technologies for 2026–2030 has been formed, which can be basic, optimistic. and pessimistic. Project issues regarding digitalization should be prospectively studied because a management project can solve specific problems regarding the implementation of specific solutions.

In paper [4], a study on digital systems in the activities of small and medium-sized businesses organized by women is reported. The process of women's understanding of digital transformations is assessed, the conditions for applying hard and soft skills, the conditions for generating digital ideas and making digital business decisions are determined. The determinants of the digital economy are formulated at relevant women's seminars that help women evolve under the conditions of digitalization. Gender issues are not often emphasized in modern scientific literature, but they are inherent in all areas of development of the digital economy.

Given current trends, research on the problems of managing transport enterprises is becoming particularly relevant in Ukraine. Thus, in paper [5], methodological principles for the formation and implementation of the potential of transport enterprises are devised, without actualization on issues of the digital realm, and in study [6], the role of organizational culture in increasing the efficiency of their functioning is substantiated and directions for the development of management as a system are determined without outlining the characteristics of this system.

In [7], the development of a comprehensive organizational and economic mechanism for managing transport and logistics services of an industrial enterprise is presented; however, the issues of administrative and psychological mechanisms for its implementation in the transport company management system remain unresolved. The role of information technologies in the management of transport enterprises is highlighted in [8], but without defining the specificity of such a role for the management system. In turn, in [9], the concept of adaptive management of innovative changes in the transport sector is proposed; however, innovative changes should go in parallel with the promotion of digital technologies and these issues are investigated in the current work on the digitalization of the transport enterprise management system.

Thus, modern scientific approaches to the transport enterprise management system combine classical management principles with the industry specificity of the transportation process. Production, logistics, financial, and service-digital subsystems are integrated to ensure competitiveness and sustainable development. The problem outlined in connection with all the listed features is to determine theoretical and applied concepts of using digitalization to optimize the transport enterprise management system. This problem has many components that must be identified during monitoring of the internal and external environment. The actualization of transport relations in the world, characterized by an increase in manufactured products and, accordingly, an increase in the need for their transportation, determines the need to simplify the mechanisms for providing transport services both within countries and in the international environment. Therefore, it is advisable to study the problems of digitalization in the transport enterprise management system to understand the directions for solving the specified problem.

3. The aim and objectives of the study

The purpose of our study is to determine the impact of the digitalization economy on the efficiency of the transport enterprise management system. This will make it possible to understand which areas of digitalization should be used

more actively to optimize management processes at specific enterprises.

To achieve this aim, the following objectives were accomplished:

– to identify the specific features of the digitalization economy in the context of the development of transport networks;

– to define the management system as an economic category;

– to identify the current features of enterprises in the transport industry of Ukraine under conditions of turbulence;

– to determine the conditions for the development of the digitalization of the transport enterprise management system (using the example of TOV TRANSPORT & Co).

4. The study materials and methods

The object of our study is the approaches to the formation of the digital economy and their impact on the transport enterprise management system.

The hypothesis of the study assumes that the management system evolves with the influence of digital approaches on it.

The assumptions adopted in the study provided for the following possibilities:

– identification of digitalization factors (such as the use of telecommunication systems, participation in social media, etc.),

– determination of the impact of digitalization factors on the management system and its main indicator – the profitability of the enterprise and the correlation between profitability and IT.

It was assumed that management factors are broader than management indicators in the perspective of profit, as an integral indicator of the enterprise's activities, and those that lie in the plane of invisible indicators.

One of the Ukrainian motor transport enterprises located in Kyiv was chosen as the base. At the request of representatives by this enterprise, its name was changed to TOV TRANSPORT & Co.

During the preparation of the study, the following materials were used: UN reports on the world transport industry, international standards, statistical data from Ukraine and other countries of the world, data from TOV TRANSPORT & Co.

As a result of the processing of the materials, the following methods were used: structural analysis and systems approach, observation and comparison, as well as mathematical methods, in particular multivariate regression.

5. Results of investigating the impact of the digitalization economy on the transport enterprise management system

5. 1. Determining the features of the digitalization economy in the context of the development of transport networks

All relations in society involve their modernization. Digitalization is considered the newest social relations. The thesis is known that digitalization significantly transforms all relations in society, a new, informational type of it is developing in an already digital society. Determining the theoretical and economic basis of digitalization processes is the task set by us in the process of conducting this study.

Thus, each science has its specific subject of study. It is connected with other related sciences through the object of study: for example, the set of economic sciences is united by the consideration of economic problems. The objective function of each science is the disclosure and knowledge of the relevant objective laws of nature or society. To do this, it relies on the achievements obtained in the process of historical development by general scientific and special, inherent only to it methods of cognition of objective reality.

The economics of digitalization involves the isolation of the connections of digitization within the framework of the entire economy and the economic system. The economics of digitalization concerns all levels of the economic system: nano-, micro-, meso-, macro-, mega-, as well as all approaches to determining the economic life of society and the needs and interests of people. It is well known that in translation from Greek the word "economics" means the art of running a household. This term was first introduced by Aristotle. He divided the science of wealth into economics and chrematistics. By the first he understood the production of goods to satisfy people's needs, by the second – the accumulation of money, to which he had a negative attitude.

Thus, the process of production of goods must be digitized, when goods and services provided to the population must have a digital expression. This is like a barcode for a product that consumers buy in a supermarket.

It should be noted that the economy as an economy has two sides of expression: firstly, as a material and natural content, and secondly, as a set of production relations that connect the processes of production, distribution, exchange, and consumption of a social product as phases of constant reproduction of the economy.

The material and natural content of the economy is manifested in the productive forces, production resources of society, reflecting the system of "human-nature" relations, which must also be digitized (translated into the information part). These include, first of all, the workforce as a person's ability to create in the material and spiritual domains. Here, the digital approach determines that there are IT specialists who help apply artificial intelligence in the production of material and spiritual goods. Thus, it is impossible to force AI to create a literary masterpiece, but it can be digitized and displayed in a certain application in order to be read using a certain gadget. And what is created as industrial property can and should be transferred to the information realm. Thus, data on the issuance of patents constitute "big data", which can be consulted to understand the state of equipment and identify your technology as capable of being patented in certain countries of the world.

Particularly important manifestations of the workforce are entrepreneurial abilities, which in principle cannot be digitized, but AI can become an assistant for starting a business, for example, using digital services of ASCs. It should also be noted that the workforce is embodied in labor resources. This is a special factor of production that is difficult to digitize but can use the full potential of artificial intelligence.

The second component of productive forces is the reified factor of production, that is, the means of production that a person uses in the process of work aimed at meeting his/her material and spiritual needs. But the means of production can be converted into a digital format when the automation of production processes occurs using AI. Here, a person is separated from these production processes, but a person must launch AI for automation and transfer the accounting of production and sales to a digital system.

The central place in the system of means of labor is occupied by the knowledge accumulated by humanity. A person

lives in a world of limited opportunities. His/her physical and intellectual abilities are limited, as is the time s/he can devote to a particular activity, and the means that can be used to achieve the goal. Knowledge lends itself well to digitization, it is "big data" that is formed at specific enterprises or government institutions. Corporations use this data to analyze and synthesize information. Intellectual abilities are also used to form information technologies and develop them. The limitation of available resources was and is the main and rather strict condition that is layered by objective reality on the size and possibilities of personal and social wealth growth. If you are informed, you are "armed". Therefore, determining the possibility of investing and launching production depends on knowing where resources are present and where they are scarce. This is data that is available in the world and can be used to make effective decisions.

It is worth noting that the set of production relations in a broad sense is represented by technical and economic, organizational, and economic and socio-economic relations.

Thus, technical and economic relations depend on digital technologies because at the current stage of their development, technologies use AI and other IT. Technologies are moving into the realm of digitalization. In particular, the real and unreal economy are subject to digitalization to varying degrees. For example, the manufacture of clothes or shoes involves manual labor and individual manufacturing. AI can be applied but does not have the same effect as the human factor component. When it comes to the mass market, the cheaper production can occur through the use of AI in the design and manufacture of clothes or shoes. It should be said that craft production is subject to digitalization more difficult than the products of industries of international competition, which are represented by corporations. Even making a soft drink with the help of AI is easier than a skirt. These international industries can also include the production of mechanical engineering products.

Organizational and economic relations can also be improved through digitalization when digital technologies are introduced in the real sector of the economy. Specific organizational and production relations are reflected in the economic systems of individual sectors of social production – the economy of industry, agriculture, and the service sector. Digitization of the production of goods and services in these macro-domains involves the formation and use of "big databases" and the transfer of technological solutions to the digital plane. Thus, AI is used for the manufacture of industrial goods to a greater extent than for the cultivation of agricultural crops. The process of manufacturing "industry-for-industry" goods and for the manufacture of consumer goods can be digital. For example, dishwashing detergent can be manufactured using digital technologies but used for the everyday lives of individuals. Also, the terms of sale and its quantity and the determination of consumption conditions can be digitized to understand feedback from consumers and identify features for product improvement. In agriculture, data on weather conditions and adjusting the growing and reclamation conditions of agricultural crops to them can be digitized. How much irrigation or fertilizer is required, these questions can be answered by digital technologies. And the register of agricultural crops can also be digitized.

The service sector also requires digitalization because the ability to provide various services depends on the conditions in which the recipients of services find themselves. Thus, logistics and transport services should be provided depending on the needs of customers. If so, then the appropriate decision is made. The algorithm of actions is such that it requires a specific company to behave in a certain way. Digital technologies are engaged in the formation of scenarios for such behavior.

General organizational and economic relations are relations in the field of monetary circulation, pricing, finance, credit, marketing, management, stock exchange, etc. They are also covered by specific economic sciences and belong to general economic theory. Thus, management is a component of organizational and economic relations and involves the management and leadership of individual economic systems from an individual to transnational corporations. When it comes to managing an individual (self-management), the processes of time and budget management can be digitized through the use of appropriate applications. When it comes to corporations, you can't do without the digitalization of business processes. Paper-based document circulation is a thing of the past; everything happens with the help of digital systems.

Socio-economic relations determine the system of "person-to-person" relations. These include the patterns of development of property relations (primarily for the means of production). Closely related to them are the distribution and reproduction of social production as a whole as an economic cycle that occurs through the production, distribution, exchange and consumption of products and services. Consumption should be based on a digital approach when property that appears as a result of the acquisition of property is digitized. Of course, if we are talking about industrial property, then it must be digitized and used with AI. Telecommunications also come in handy when something is bought or sold. E-commerce is the factor on which the quality of socio-economic relations depends. The reduction of the distance between the seller and the buyer and the quality of delivery are the levers that encourage the development of consumption and the establishment of logistical connections in economic systems. In the consumption system, distances are being reduced and globalization processes are intensifying. It should be noted that digitalization and globalization are the factors that activate economic development at different levels of economic systems. In addition, we emphasize that the digital economy is developing at different levels, which should be discussed separately.

Thus, we note that the digitalization of global systems involves the inclusion of AI and inclusion in electronic networks of international economic organizations. Obtaining services from the UN or WTO, or International Courts is a problem of bureaucracy. When artificial intelligence and an electronic approach to case management are used, the mechanisms for conducting cases are simplified. At the stage of submitting applications to solve specific problems, elements of the digital economy can be used.

When it comes to integration formations, such as the European Union or MERCOSUR, we are talking about the use of e-government. Digital technologies are used to reduce distances and provide high-quality public services, a powerful potential for the growth of regions is formed, and the productivity of cooperation between authorities and the population and enterprises is improved.

At the state level, digital processes are also being updated, in particular, there is a sufficient number of scientific works on e-government of state power. Scientists interpret digitalization as digitalization, by which they understand the process of implementing digital technologies to improve the life of a person, society, and the state.

At the regional and industry levels, synergistic approaches to the use of AI and other aspects of digitalization are being formed. A special phenomenon at the meso-level of the economic system are industrial districts or, as they are also called, clusters. Here, it is necessary to unite entrepreneurs of one industry and one region into clusters in order to increase the productivity of individual entities of these clusters. When the joint actions of cluster participants are strengthened and lead to improved performance. Electronic document management becomes the property of cluster actors to improve and reduce the distance of relations.

Another level of the economic system is enterprises. There is a lot of talk about the digitalization of their activities. If we are talking about individual entrepreneurs, this is the use of electronic methods for conducting trade and business. Transport enterprises also actively use digitalization to provide quality services. This digitalization includes actions from communication with weather services to understand weather conditions and information for customs on the quantity and quality of goods. All this is to understand the needs of counterparties and to observe the trajectory of goods movement.

The nano level is also the level of development of the economic system. This is the level of an individual. Here, IT can be useful for shaping the business processes of an individual and can also be the subject of their work. When an individual entrepreneur or just a person working as a freelancer uses their baggage to form startups that operate with artificial intelligence.

It should be noted that the economy of digitalization can, under certain circumstances, affect the development of enterprise management systems in various sectors of the economy. And it is necessary to clearly define the boundaries of the development of management systems and the impact of digitalization aspects on them.

5. 2. Management system as an economic category

The relevance of enterprise management under modern conditions is due to the need for its adaptation to the processes of globalization and digital transformation. It is under conditions of high competition, the growing role of innovation, and market integration that there is a need to form flexible management systems. They are able to respond quickly to the challenges of the external environment and ensure stable functioning. At the same time, information technologies, artificial intelligence, and "big data" act not only as tools for optimizing business processes. They are powerful sources of creating new added value, which determines the strategic guidelines for the development of enterprises in the global economic space. Thus, the Industrial Development Report for 2022 by the United Nations Industrial Development Organization emphasizes that digital solutions and automation are key determinants of industrial renewal and the basis of sustainable development. Therefore, an effective management system is a strategic task that determines the competitiveness of enterprises at the national and international levels.

It should be noted that a management system (Greek: systema – a whole composed of parts; connection) is a set of elements that are in relationships and connections with each other and create a certain integrity, unity [6].

In modern management practice, the definition of the concept of "management system" is enshrined in international ISO standards, which serve as a universal basis for building organizational mechanisms in various areas. According to ISO 9000:2015, "a management system is a set of interconnected or interacting elements of an organization that is used to establish policies and goals, as well as for the processes necessary to achieve these goals."

In general, an enterprise management system is a multi-level structure that aligns internal resources with the requirements of the external environment. The concept of "enterprise management system" in classical science was based on approaches to the organization of production and administrative activities.

In the second half of the twentieth century the emphasis shifted from regulation to strategic management. Thus, in the second half of the twentieth – early twenty-first centuries. the enterprise management system was transformed from a stabilizing mechanism into a strategic and innovative tool focused on flexibility, adaptability, and competitiveness.

Currently, the strategic dimension of management is focused on the long-term positioning of enterprises in global competition through unique advantages and innovative business models. Digitalization and technological changes (Industry 4.0, big data, AI, IoT) create new tools for adaptation and efficiency improvement. In the context of globalization, the importance of a system-network approach to managing ecosystems and supply chains is growing. Sustainable development, which integrates environmental, social and governance (ESG) parameters, plays an important role, building investor confidence. At the same time, the behavioral dimension emphasizes the role of leadership, corporate culture, and emotional intelligence. The conditions of the digital economy determine the construction of business management based on intelligent data. The use of "big data" and machine learning algorithms makes it possible to optimize resources and reduce costs, increasing competitiveness.

In general, the modern transport enterprise management system is interpreted not only as a coordination mechanism but as a strategic resource that ensures flexibility, innovation, and sustainability. It is characterized by adaptability and the ability to respond quickly to changes, integrating management, information, and technological mechanisms to maintain efficiency and create competitive advantages. It should be emphasized that the transport enterprise management system is a complex multi-level organizational and economic structure that integrates strategic, tactical, and operational decisions into a single logic of functioning. The strategic level determines the mission, development policy, investment and competitive strategy, integration into national and international logistics networks. The tactical level implements route planning, tariff policy, cost optimization and technical support, ensuring financial balance and profitability in the medium term. The operational level covers dispatching, cost accounting, load control and quality of transportation, which directly affects economic efficiency and demand satisfaction. Consistency between levels ensures the integrity of management and sustainable development of transport enterprises in a changing environment.

Management of a transport enterprise is carried out by implementing four basic functions: planning, organization, motivation, control. The effective implementation of these functions is facilitated by the coordination function, which ensures a systematic relationship between the basic functions. The management process, as a process of implementing functions, is carried out in a certain sequence and to achieve a certain goal of the enterprise's activities. The basic stage that determines the entire further process of managing the enterprise is the stage of setting goals.

The objective function of the transport enterprise management system is to ensure the effective use of material,

financial, and labor resources, the continuity of the transportation process, economic efficiency and traffic safety, which ultimately ensures the satisfaction of society's needs in transport services. From an economic point of view, the management system performs the function of transforming resources into results and effects, forming synergy between the internal potential of the enterprise and the requirements of the external environment.

It should be emphasized that the methods of managing transport enterprises are divided into administrative, economic, and socio-psychological. The combination of a set of tools requires a scientific basis, which ensures their coordinated application within the framework of an integrated management system. That is why the basis for developing a management mechanism is a system of methodological principles that reflect the enterprise as a complex socio-economic system. Universal principles include: the principles of science, systematicity, adaptation, self-organization, emergence, flexibility, hierarchy, stability, security, integrity, consistency of goals and complexity. Special principles of management in the transport sector include the following principles:

– optimal compliance of development with public needs – priority of state and consumer interests over private ones;

– environmental soundness – consideration of the impact of transport networks on the environment and the introduction of "green" technologies;

– interdependence and equivalence – formation of partnership relations between transport network entities regardless of the form of ownership or scale of activity;

– economic feasibility – assessment of the socio-economic consequences of the activities of network structures, taking into account competitiveness, quality, safety, and cost reduction.

The components of the enterprise management system are subjects (management bodies, managers, functional services) and management objects (production units, vehicles, personnel), management relations, regulatory mechanisms and information support. The interaction of these elements ensures the integrity and effectiveness of management, as well as the ability of the enterprise to self-regulate and develop.

Thus, the transport enterprise management system can be considered as an integrated organizational and economic mechanism that ensures the consistency of planning, organization, motivation, control and regulatory and coordination influences. Its essence is the combination of various means of influence that form the integrity of management activities and are characterized by a multi-component structure.

The organizational and economic mechanism of the transport enterprise management system includes:

– organizational tools (optimization of the management structure, dispatching, rationalization of the route network);

– economic tools (tariff policy, financial incentives, investment support, planning of costs and revenues);

– administrative tools (regulation of transport activities, licensing, safety standards);

– legal tools (normative and legal support, consistency with state policy and international agreements);

– socio-psychological tools (corporate culture, professional motivation of personnel, safety culture).

The enterprise management system is influenced by the conditions of digitalization. How transport enterprises are organized and what they are characterized by determines the directions of use of digital technologies.

5. 3. Development of Ukrainian transport industry enterprises under turbulent conditions

The transport industry of Ukraine is a key element of the national economy, integrating Ukraine not only into European markets but also into the global transport space with access to international markets and global transport flows. The transport industry accounts for more than 12% of GDP in the national economy; it also provides 7% of jobs [10]. After the illegal annexation of the Autonomous Republic of Crimea and part of the eastern territories of Ukraine, significant changes occurred in the transport and logistics chains, and after the full-scale invasion by the aggressor country of Russia, the functioning of transport enterprises takes place under conditions of high turbulence and uncertainty, which is due to the occupation and hostilities in the territory of eastern, southern, and partly central Ukraine, which led and continues to lead to the destruction of transport infrastructure, the blocking of seaports, increased costs, and the constant need to diversify routes to ensure safe conditions for rendering transport services [11, 12].

In the scientific literature, turbulence is interpreted as a special state of the economic system when the interaction of political, social, and economic factors creates a "chaotic regime" of development, which makes it impossible to use standard management tools [11], but it should be noted that turbulence, which is formed under the influence of military and aggressive actions, has some differences compared to turbulence formed by global crises and market instability; therefore, it can be defined as a set of unpredictable and rapid changes in the external environment associated with military actions and non-compliance with the norms of international law, which form unpredictable and unstable conditions for the functioning of enterprises and increase the level of risk of their activities to critical, and sometimes to complete destruction of infrastructure within certain regions located on the front line, as well as in the rear.

The main factors that directly affect the generation of increased turbulence in the transport system of Ukraine are:

– full-scale military invasion and annexation of territories, which led to the destruction of infrastructure, blocking and closing of established routes and their reorientation to other directions, attacks on logistics facilities;

– global crises and the crisis in the national economy, as a result of the destruction and change of supply chains, energy crisis, changing conditions in international trade and access to international markets;

– market instability, namely fluctuations and changes in the structure of demand for transportation, investment deficit – unwillingness of foreign investors to enter the Ukrainian market, risks of currency fluctuations [13].

The existence of such a set of factors that increase turbulence in the transport industry of Ukraine requires changes in approaches to the formation of strategic development of transport infrastructure under such conditions; therefore, managing enterprises under turbulent conditions requires the use of adaptive strategies that can quickly respond to unpredictable changes and ensure the stability of the business model [14].

The development of transport enterprises in Ukraine under conditions of constant turbulence and uncertainty is uneven between segments of the transport system. Specifically, the largest share of the country's freight transportation, up to 60%, falls on railway transport and it retains a critical importance in ensuring transportation, although it should

be noted that since the beginning of the full-scale invasion, railroad transport has been under constant attacks on infrastructure: in 2025, shelling led to damage to substations and railroad junctions, damage to the railroad tracks [15]. The second place is occupied by road transport, which accounts for about 30% of transportation – this type of transport is more adapted to turbulent operating conditions due to the flexibility of routes, but also has certain disadvantages associated with high fuel costs and downtime at the borders [16]. The aviation sector remains almost completely paralyzed due to the closure of airspace over the territory of Ukraine, while maritime transportation has begun to recover due to the development of Danube ports and the functioning of "solidarity corridors" [12, 17, 18] (Fig. 1, Table 1).

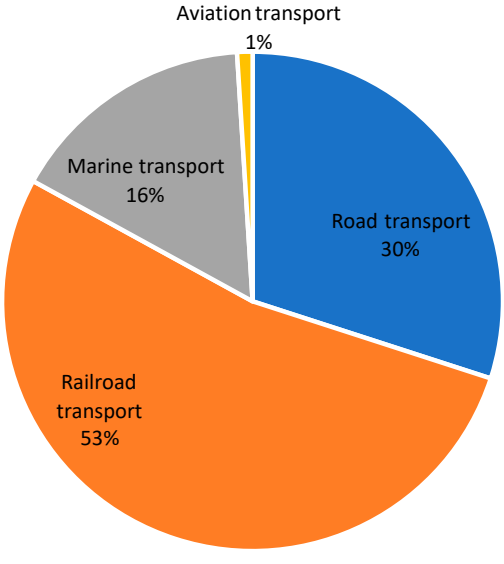

Fig. 1. Structure of freight transportation in Ukraine in 2023 (%) [11]

Table 1

Dynamics of freight transportation in Ukraine by mode of transport, 2019–2024 (million tons)

Year	Railroad	Automotive	Marine	Aviation
2019	312.0	180.5	157.4	0.9
2020	305.4	172.1	145.8	0.5
2021	308.7	178.3	153.2	0.8
2022	256.1	120.4	42.7	0.1
2023	241.3	114.8	35.2	0.1
2024	250.0	122.0	49.0	0.2

Source: compiled by Authors based on [18, 19].

Under the current conditions of the functioning of the transport sector of Ukraine, the following risk groups are formed, which should be taken into account in the strategic planning of the development of transport infrastructure (Table 2):

1. The first group of risks is the destruction of infrastructure, logistics, equipment, reduction of cargo flows and reduction of the safety factor. Railroad tracks, stations, and seaports have become one of the most affected objects of critical infrastructure, according to estimates for 2022–2024, losses of seaport capacities amounted to more than 60%, which led to a significant decrease in cargo turnover [19], similarly, systematic attacks on railroad infrastructure lead to delays, changes in routes, and increased transportation costs [15].

2. The second group of risks is financial risks, associated with a significant increase in costs for logistics, cargo insurance, and repair of damaged facilities, which leads to a decrease in the profitability of transport enterprises. According to international consulting companies, in 2023 the cost of logistics for Ukrainian carriers increased by 1.5–2 times compared to the pre-war period [20].

3. The third group of risks is staff turnover and shortage; since the beginning of the full-scale invasion there has been and is a mass migration of the population, mobilization of workers and outflow of specialists to safer regions, departure to other countries, which led to a shortage of personnel in the transport sector and the loss of highly qualified categories of personnel – machinists, logisticians, and aviation engineers, etc. [16].

4. The fourth group of risks is geopolitical challenges, namely the loss of access to traditional eastern and southern transit routes, which led to the reorientation of Ukraine's transport architecture towards the EU and the formation of "solidarity corridors", which partially compensated for the losses of maritime infrastructure, but raised the question of organizing integration processes into the European TEN-T transport system and harmonization with regulatory standards, which increased the requirements for Ukrainian transport enterprises [21]. According to expert estimates, in 2022–2024, direct losses to Ukraine's transport infrastructure were estimated at over USD 170 billion [19], and post-war recovery requires the formation of a comprehensive strategy that will combine state resources, international assistance, and innovative business models.

Table 2

Challenges and possible adaptation measures for transport enterprises

Challenge category	The essence of the problem	Potential adaptation measures
Infrastructure destruction and reduced freight flows	destruction of ports, railroads, reduction of sea transport by > 60% in 2022–2023	– recovery and modernization of infrastructure with support from the World Bank and the EU
Financial risks	increase in costs for insurance, repairs, logistics (up to 1.5–2 times higher than the pre-war level)	– attracting international funding (Horizon Europe, EBRD); – public-private partnerships; – subsidizing logistics in critical sectors
Human Resources issues	migration and mobilization of workers, shortage of specialists (drivers, logisticians, aviation engineers)	– personnel return programs; – training of new specialists in partnership with universities, retraining of veterans; – use of digital technologies to automate processes
Geopolitical challenges	loss of access to traditional routes, need for integration into TEN-T	– development of "solidarity corridors"; – harmonization of standards with the EU; – expansion of logistics clusters in border regions

Source: compiled by Authors based on [12, 14–22].

Since the beginning of the large-scale invasion, the transport infrastructure has been in an increased turbulence of the external and internal environment, which requires Ukrainian transport enterprises to apply adaptive development strategies based on the diversification of routes, the use of new infrastructure opportunities and innovative management solutions. Specifically:

First, the reorientation of cargo flows to the western borders. Since the beginning of the full-scale war, the main tool for stabilizing transportation has become the "solidarity corridors" set up by the EU and Ukraine in 2022. They made it possible to ensure the continuity of exports and imports under the conditions of the blockade of the Black Sea ports; according to official data from the European Commission, from May 2022 to May 2025, more than 187 million tons of cargo were transported through these routes, including agricultural produce, ore, and oil products [12, 23], which indicates the formation of a new transit architecture integrated with the European TEN-T system.

Second, the development of the Danube ports of Reni, Izmail and Kiliya; these logistics hubs have become key for the export of grain and metal products in 2023–2024. According to study [10], the potential of the Danube ports is several times higher than the pre-war indicators, and the modernization of hydraulic structures makes it possible to redistribute part of the traffic that previously went through Odesa and Mykolaiv. According to USDA reports [18], it was thanks to the Danube route that grain exports were stabilized, and foreign exchange earnings were secured for the agricultural sector.

Third, the implementation of digital solutions. Ukrainian transport companies are actively using e-commerce and digital document management tools, and an important step was the large-scale use of electronic invoices, which reduced cargo processing time and reduced transaction costs, and the integration of GPS tracking systems, big data analytics and IoT solutions for monitoring logistics flows. OECD [14] and ITF-OECD [24] analysis indicate that digitalization provides up to 15–20% cost savings and a significant increase in the transparency of transportation under crisis conditions.

Fourth, attracting international investment. The restoration of transport infrastructure and the modernization of management systems are possible only if external financial resources are attracted; the programs of the World Bank, the EU, and Horizon Europe are aimed at financing road reconstruction projects, modernization of ports and railroad junctions, as well as supporting digital innovations in the transport sector [14, 19], which would create conditions for the long-term integration of the Ukrainian transport system into the European transport system and the formation of a sustainable business model for enterprises in the industry. Referring to international experience, we note that the crisis resilience of transport systems is possible through integration into regional logistics networks and digitalization of management (Table 3).

Table 3

International experience in increasing the resilience of transport systems and its relevance for Ukraine

Country/ Company	Examples of practices	Results/effects	Application in Ukraine
Poland and the Baltic States	Modernization of railroad junctions (Lublin, Kaunas, Riga), integration of the ports of Gdansk and Klaipeda into TEN-T	Reducing dependence on Russian routes, intercepting transit flows	Integration of Ukrainian corridors into TEN-T, development of logistics hubs in Lviv, Uzhhorod, Chop
EU (COVID-19 pandemic)	Green corridors, electronic customs services, digital flow monitoring	Reduced transit time, reduced delays by 20–25%	Implementation of full-fledged e-customs and border management systems
Maersk	Maersk Flow platform for tracking and optimizing routes	Transparency of supply chains, reduced delays in ports	Development of similar platforms for Ukrainian ports and railroads
DHL	Resilience360 program (risk analysis through big data, AI)	Ability to adjust routes in advance and find alternative suppliers	Creation of a national logistics risk management system based on big data
DB Schenker	Automated warehousing, robotics, IoT sensors in cargo	Increase efficiency and safety of transportation	Using IoT solutions in grain and pharmaceutical transportation
Scandinavian countries (Sweden, Denmark)	Volvo electric trucks, energy-saving green ports	Reduce emissions, long-term sustainability	Integrating green logistics projects into the post-war recovery process

Source: compiled by Authors based on [10, 21, 24].

Based on Table 3 and our analysis of international practices, we can see that since 2014, after the annexation of Crimea, Poland and the Baltic countries have begun to actively develop alternative transit routes, reducing dependence on Russian ports and transit corridors. Large-scale infrastructure projects have been implemented to modernize railroad hubs in Lublin, Kaunas, and Riga, as well as the integration of the ports of Gdansk and Klaipeda into the TEN-T system. This has allowed the Baltic countries and Poland to reorient a significant share of transit flows from Ukraine and Belarus, ensuring the stability of their transport systems even under crisis conditions [21].

During the COVID-19 pandemic, the European Union implemented a whole set of measures aimed at maintaining the stability of transport systems, with digital solutions of particular importance, ensuring the continuity of transportation during the period of quarantine restrictions. For example, the introduction of electronic "green corridors" has significantly reduced the time for goods to pass through customs checkpoints, and real-time flow tracking systems have helped avoid chaotic disruptions in logistics [20].

International logistics companies have also acquired significant experience in adapting to crisis situations:

– Maersk has implemented an integrated platform, Maersk Flow, which allows customers to track shipments in real time, predict delays, and optimize routes – especially effective during seaport disruptions;

– DHL has implemented the Resilience360 program, which uses big data and artificial intelligence to analyze risks in global supply chains, from geopolitical to climatic, allowing customers to change routes or find alternative suppliers in advance;

– DB Schenker has expanded the use of automated warehousing and robotic cargo handling systems, which has increased the efficiency of logistics operations during peak load periods. The company is also actively using IoT sensors to monitor temperature, humidity, and transportation safety, which is critical for pharmaceutical and agricultural products [24].

After the global energy crisis of 2021–2022, the Scandinavian countries focused on ecological transport and digitalization of transport infrastructure (Volvo electric trucks, green port projects in Sweden and Denmark). This combi-

nation of digital solutions and ecological modernization has become an example of a long-term strategy to increase the sustainability of the transport system. Such experience for the Ukrainian transport system is extremely valuable for overcoming problems associated with high environmental turbulence, integration into TEN-T, large-scale use of big data and digital platforms in logistics can ensure the functioning of the transport system during the pandemic and recovery after the war.

It should be noted that under conditions of turbulence, the forecast for the development of the transport sector of Ukraine is of a scenario nature. According to the World Bank and OECD, the further development of the transportation system depends on the duration of military operations, possible further destruction of the transport infrastructure, the scale of international support, the speed of infrastructure restoration and the level of integration into the European TEN-T network [14, 19]. Therefore, depending on this, there are three possible development scenarios (Fig. 2):

– optimistic, which involves rapid restoration of infrastructure, attracting large-scale investments and integration into TEN-T;

– basic, which is based on gradual restoration and moderate growth through a combination of state and international resources;

– pessimistic, which is associated with a prolonged financial deficit and slow modernization.

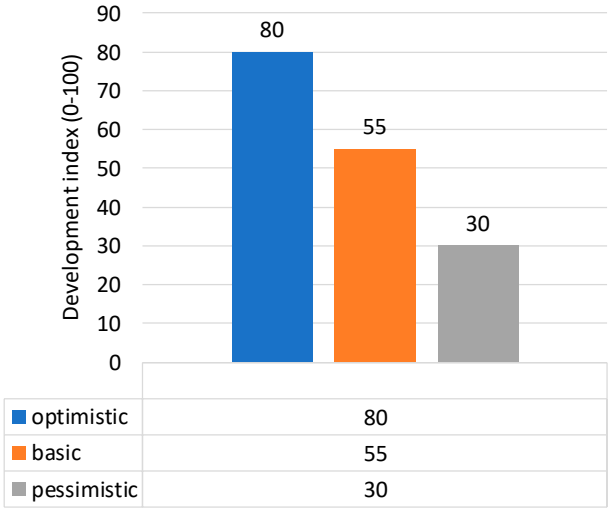

Fig. 2. Scenarios for the development of the transport industry in Ukraine after the war [7, 17]

The main strategic prospects for the development of the transport system of Ukraine, under conditions of increased turbulence, are as follows:

1) integration into the European TEN-T network has a dual significance for the domestic transport system: ensuring access to European logistics corridors and reducing dependence on unstable directions. And in the post-war period, integration will allow Ukrainian carriers to fully integrate into the trans-European transit system, increase funding for infrastructure projects and increase competitiveness. It should be noted that the modernization of the railroad infrastructure is critically important, namely the transition of part of the routes to the European track, the development of border hubs and the connection of Danube and Black Sea ports to a single TEN-T system [21];

2) modernization of infrastructure and bringing it into line with EU standards. In the long term, the reconstruction of transport infrastructure in accordance with EU requirements: increasing safety, implementing environmental standards, using "green technologies", which in the long term will lead to the restoration of the pre-war level of transportation, as well as to increasing sustainable development and energy efficiency;

3) digitalization of management processes. Implementation and development of digital platforms for managing cargo flows, electronic invoices, GPS tracking systems, big data and IoT, which will make it possible to increase efficiency under crisis conditions, and in the post-war recovery, digitalization will become the basis for the integration of Ukrainian logistics into the European digital environment (e-customs, a single transport space), which will ensure increased speed and reliability of transportation [14, 24];

4) diversification of funding sources. Turbulence and war risks limit the capabilities of the state budget, so the key task is to actively attract external resources. Thus, the World Bank, the EU, the EBRD, and Horizon Europe finance projects for the reconstruction of roads, modernization of ports and railroad junctions [19], in the post-war period these programs should become the basis for larger-scale modernization, and public-private partnerships will contribute to the mobilization of domestic business capital. Such diversification will make it possible not only to restore the infrastructure but also to lay the foundation for its innovative development.

The identified trends and risks associated with the development of Ukrainian transport enterprises under turbulent conditions shape the directions of short-term anti-crisis solutions and long-term strategies focused on integration into the European and global space, which makes it possible to form the main conditions for the development of the industry and predict the expected results from their implementation at different stages – during the war period and during post-war recovery (Table 4).

Table 4

Key conditions for the development of transport enterprises in Ukraine and expected results

Key development conditions	Expected results in conditions of turbulence and war	Expected results in post-war reconstruction
Integration into the European TEN-T network	Providing access to alternative routes, reducing dependence on unstable directions	Full integration into TEN-T, increased transit potential, creation of new border hubs
Modernization of infrastructure taking into account EU standards	Restore destroyed facilities, maintaining minimum capacity	Reconstruction according to European standards, ecological and energy-efficient logistics, development of «green ports»
Digitalization of management processes	Increase transparency and speed of transportation under crisis conditions, minimizing corruption risks	Formation of a single digital logistics space with integration into e-customs and EU systems, reduction of delays by 15–20%
Diversification of funding sources	Attract external resources to support critical transportation	Large-scale investments from the EU, World Bank, EBRD, and Horizon Europe, development of public-private partnerships

Source: compiled by Authors based on [14, 19–21, 24].

These conditions act as protective mechanisms for the transport system when operating in a complex turbulent environment, making it possible to ensure survival and minimize losses, and in the post-war recovery they form the basis for the strategic development and transformation of the transport industry in Ukraine and the European transport system.

5. 4. Conditions for the development of digitalization of the transport enterprise management system (using the example of TOV TRANSPORT & Co)

The transport and forwarding company "TRANSPORT & Co" has been present on the Ukrainian freight transportation market for over 7 years. Domestic transportation is the main direction of the company's business, but the company is beginning to enter the international arena.

We also emphasize that road transportation of various cargoes is one of the most optimal types of transportation. Such transportation becomes the basis for cargo delivery, taking into account all the features and specific characteristics of the goods. An individual approach is the path that the company follows to scale the business and grow into a corporation.

The time-tested experience and professionalism of the staff allow the company:

– to promptly carry out cargo transportation of various volumes across Ukraine and in the external environment;

– to track the movement of each specific cargo;

– to offer such services that characterize an acceptable price-quality ratio;

– to guarantee a high level of transport services.

As we can see, all processes involve the use of digital technologies.

The company "TRANSPORT & Co" uses various types of vehicles for cargo transportation (both its own and external). The largest number of road transportations is carried out by tented vehicles with a carrying capacity of close to 20 tons. Such vehicles transport packaged and piece goods, which is the main type of products transported.

Technical characteristics of trucks that take part in cargo transportation by the company "TRANSPORT & Co":

– tractors that meet the requirements of "EURO V" coupled to tilt semi-trailers;

– semi-trailer volume 86 cubic meters;

– semi-trailers with a sliding roof and rear doors.

For the customers, the company always provides:

– provision of vehicles in accordance with the customer's requirements, which occurs with the use of artificial intelligence, when a car is selected according to the specificity of the cargo quality;

– development of an optimal schedule, route, and delivery scheme, using various applications or developing its own program using IT;

– involvement of additional equipment for the transportation of non-standard cargo when AI is also used to match oversized cargo to transportation conditions;

– expeditionary control and information support 24/7 – this is what qualitatively involves the use of various digital systems.

Among the goods transported by the company "TRANSPORT & Co" are such brands as Coca-cola, Obolon, Slavutych, Morshynska, Myrhorodska, Sandora, "Nash Sik", a complex of factories of the SunInBev Ukraine holding, and "Biola".

Beverages are the goods that are actively transported by the company. The shipment of goods is carried out on pallets and the number of pallets in one batch is 33 units.

"TRANSPORT & Co" also transports goods of lesser-known brands. It should also be noted that the company carries out transportation of oversized cargo, such as metal structures, which are delivered to one of the most important clients.

It should be noted that the linear organizational structure of the company "TRANSPORT & Co" is shown in Fig. 3. This structure reflects the specificity and features of transportation and forwarding services. The company's structure includes logistics managers who connect the client and the carrier. For the digital realm, the activities of an IT specialist are provided.

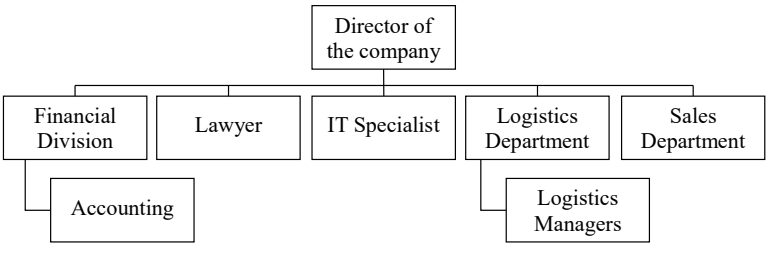

Fig. 3. Organizational structure of the company "TRANSPORT & Co"

In the enterprise management system, a planning function is distinguished when the director formulates a strategy and monitors its achievement. The head of the company also coordinates all types of work and conditions for managing the company. S/he also determines the implementation and formation of approaches to motivating the work of all employees of this enterprise. And all approaches use artificial intelligence.

The organization function in the enterprise management system highlights the use of social networks, 50% of the staff use them and this pushes the management to use time management. Such time management helps organize the current activities of employees and the use of social networks for the benefit of current activity of the company.

Digitalization is also used in employee motivation when the employee sees his/her achievements and can understand what material and non-material incentives can be used. Transparency in matters of remuneration is an element of stimulating the productivity of all employees of the company "TRANSPORT & Co".

The coordination function involves the use of artificial intelligence to bring elements of electronic document flow to all subordinates that the movement of the transport company's activities is taking place in the general direction of the company's strategic development.

Control as a function of the management system of the company "TRANSPORT & Co" also takes place with the use of digital technologies. Reports on the work of employees are transferred to electronic circulation since control should concern all aspects of activities to ensure the strategic development of the enterprise.

It should be noted that the management system of the company "TRANSPORT & Co" is typical of medium-sized enterprises. The company employs up to 50 people. The company plans to scale up and transition to the rails of large business. In order to make such a transition from an LLC to a joint-stock company (corporation), the company must find opportunities to purchase a fleet. It must also have an infor-

mation technology specialist on staff, who should provide all the latest approaches to managing the system of relations within the transport enterprise.

Let's apply factor analysis to determine the impact of individual features of digital technologies on the profitability of the transport enterprise "TRANSPORT & Co".

The calculation of multifactor regression is given below.

The data for analysis by the multifactor regression method of the enterprise "TRANSPORT & Co" are given in Table 5.

Table 5

Input data for multivariate regression

Date	Profit of the enterprise, USD	Telecom. services, USD	E-mails sent, pcs.	Corporation telephones, USD	Social media participation, %
01.2024	902358	560	15012	231	50
02.2024	1045986	657	15489	247	51
03.2024	1097324	421	15289	250	57
04.2024	1139752	405	15023	248	52
05.2024	1278934	402	16002	239	53
06.2024	1245762	412	15879	251	54
07.2024	1473960	407	15426	253	54
08.2024	1378961	401	15423	252	53
09.2024	1400023	412	15401	247	55
10.2024	1573025	402	15349	250	54
11.2024	1239078	412	14963	254	52
12.2024	1325962	408	15102	261	56

Fig. 4 shows a linear relationship, the coefficients of which are obtained by the least squares method.

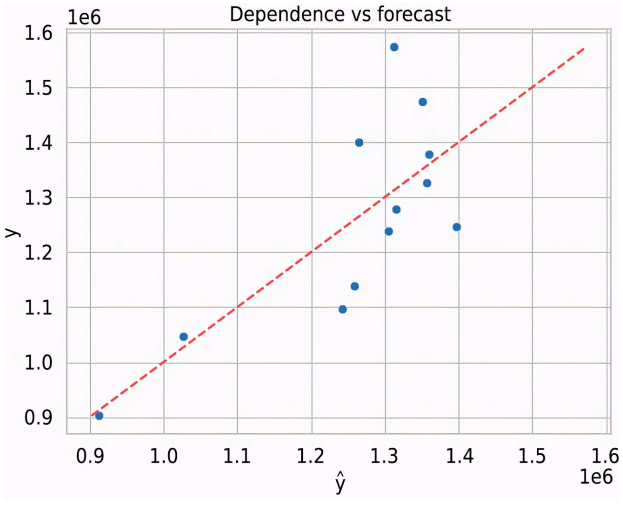

Fig. 4. Linear dependence vs forecast

As can be seen from Fig. 4, a linear relationship is not suitable for describing the relationships between these data sets:

1. Model quality:

– $R^2 = 0.580$: the model explains ~58% of the variation in the objective variable Y;

– Adj. $R^2 = 0.340$: after taking into account the number of predictors, the quality decreases. This is a signal that not all factors make a significant contribution, and the model may be overloaded;

– F-statistic = 2.416, $p = 0.146$: the model as a whole is statistically insignificant at the 5% level. That is, it cannot be confidently stated that the set of factors really explains Y.

2. Coefficients:

– none of the predictors (X1–X4) has $p < 0.05$, i.e., there is no statistically significant effect with this sample size ($n = 12$);

– closest to significance – X1 ($t = -1.7$, $p = 0.133$), but still > 0.05;

– confidence intervals are very wide (for example, X4 from –90 thousand to +66 thousand) → instability of estimates.

3. Model assumptions.

The plot of model residuals is shown in Fig. 5.

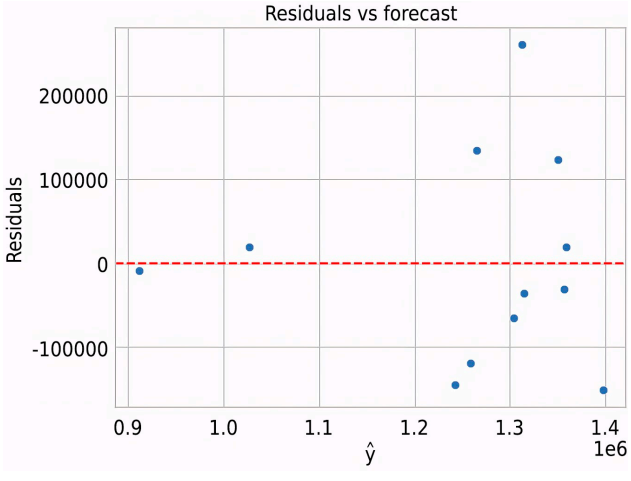

Fig. 5. Plot of model residuals

The residual plot (Fig. 5) demonstrates that the main part of the dependences is not taken into account in the model, but "fell" into the residuals, therefore there is autocorrelation:

– Durbin-Watson test = 1.625: slightly below 2 → possibility of positive autocorrelation, but not critical;

– Breusch-Godfrey test = 11.655: there is a statistically significant autocorrelation in the residuals.

The lags of the model residuals are illustrated in Fig. 6.

In general, the series of residuals (Fig. 6) is not "white noise". There are signs of low-order positive autocorrelation (for example, at lags 1–2 there are small positive correlations, at lag 4 there is a significant negative one).

The distribution of residuals of conceptual definitions is shown in Fig. 7.

The QQ-plot (Fig. 7) shows that the residuals are normally distributed.

Jarque-Bera test $p = 0.62$: the residuals appear normally distributed (normality is not rejected).

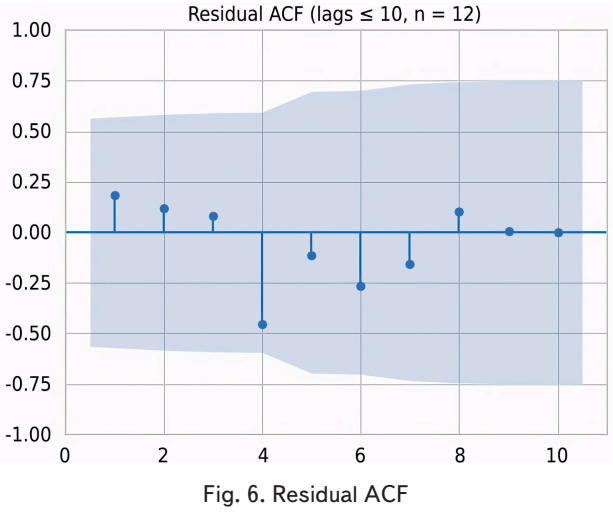

Fig. 6. Residual ACF

Breusch-Pagan test = 1.703, p=0.7901: the residuals are homoscedastic, there is no evidence of heteroscedasticity.

White's test = 12.0, p = 0.364: there is no evidence of heteroscedasticity.

The correlation matrix is shown in Fig. 8.

Fig. 7. QQ-plot of residuals

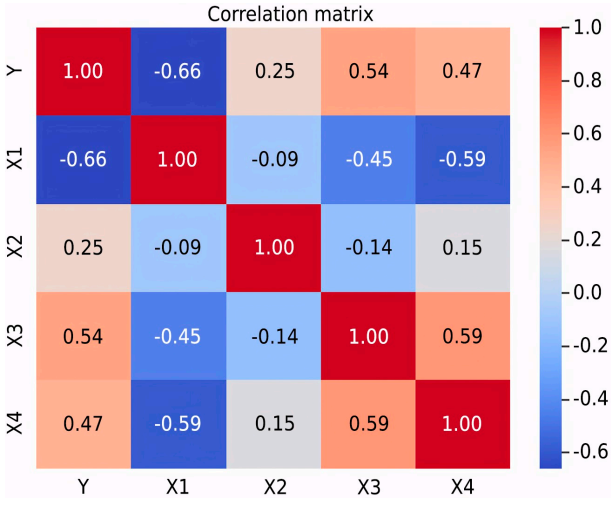

Fig. 8. Correlation matrix

VIF:

	feature	VIF
0	const	5313.123782
1	X1	1.580022
2	X2	1.117849
3	X3	1.708425
4	X4	2.058314

Condition number (SVD, standardized X): 2.55

VIF (Variance Inflation Factor)

– X1 = 1.58, X2 = 1.12, X3 = 1.71, X4 = 2.0

All values are far below the critical thresholds (5 or 10).

There is practically no multicollinearity between the variables.

Condition number = 2.55 is a very low value. This confirms that there is no multicollinearity.

4. Conclusions:

1. The model is generally weakly significant due to the small sample size (12 observations for 4 predictors) and strong multicollinearity.

2. There are no significant coefficients, it is currently impossible to identify the key factor.

3. There is autocorrelation of the residuals.

The conclusions of our regression analysis show that digitalization does not significantly affect the efficiency of the transport enterprise. Profitability depends on many factors but IT factors are not significant for the possibility of generating income and profit, respectively. To distinguish digital technologies, it is necessary to have significant indicators of the use of artificial intelligence and other aspects of the application of the digitalization process.

Modern transport enterprises, including TRANSPORT & Co., are actively implementing such digital tools as logistics management systems (TMS), automated vehicle monitoring platforms (GPS/IoT), electronic document management, cloud services for data processing, analytical modules for demand forecasting, as well as integrated CRM systems for interaction with customers. The use of these technologies makes it possible not only to optimize operational processes but to form new business models, increase the level of service, and ensure competitiveness in the market.

All these elements of digitalization can be implemented using telecommunication technologies, in particular the INTERNET network, and the use of smartphones and other gadgets. Payment for such telecommunication services should be paid by the enterprise, and they should correspond to the corporate culture of the given transport enterprise.

The results of our study, in particular the multifactor regression, prove that the transport business should develop through the implementation of digital technologies. After all, all processes from the main ones to the auxiliary ones should be guided by elements of digital systems. The digital data that was received from the enterprise does not sufficiently correlate with the profitability of the company, but their importance cannot be ignored.

6. Discussion of results of investigating the impact of digitalization on the management system of transport enterprises

The results of our study are attributed to determining the aspects of the economy of digitalization in the management systems of transport enterprises. In particular, Fig. 1–3 show the features of the development of transport enterprises in Ukraine. Tables 1–4 determine the application of digital technologies and reflect the features of digital systems at these enterprises. Also, the multifactor analysis conducted determines the relationship between the profit of a particular enterprise and such factors as telecommunication services, the number of emails sent, the cost of using corporate smartphones and participation in social media. The results of this analysis are illustrated in Fig. 4–8.

The proposed solutions for activating the use of digital technologies (automation of transport services, use of CRM technologies, etc.) involve diversifying digital approaches and not just using electronic document management or telecommunication services. This aspect is different from existing concepts and research results because digitalization is much broader than just the use of electronics and its capabilities.

The results obtained close the problematic part, such as the need to simplify relations and build new connections in the transport system of a certain country. Of course, the problem is only partially closed since the transport system is out-

lined by the activities of enterprises of different sub-sectors (automobile, aviation, railroad, maritime, pipeline). Digital systems differ at the enterprises of each of these subsystems. But thanks to the analysis of the motor transport enterprise, it can be noted that the potential for the development of digital solutions is present at such small and medium-sized enterprises. This is explained by the fact that the movement of goods by cars is a priority area for the development of land transport in Ukraine under conditions of military operations. Unlike the railroad infrastructure, which is subject to attacks from the aggressor country, motor transport enterprises can serve as a model of security technologies.

To apply the solutions in practice, it is necessary to take into account the aspect of diversifying digitalization factors. And in further theoretical studies, it is necessary to take this aspect into account and ensure the use of other statistical methods, such as game theory to determine the competitiveness of digital solutions, cluster analysis to determine consumer categories and their focus groups. It is also necessary to determine an integral indicator of the quality of the enterprise management system, in particular, transport.

The disadvantages of our study relate to the fact that the average-sized enterprise is considered. Most enterprises in the motor transport subsector are small and compete with large businesses of large carriers. Small businesses have other digitalization schemes, as well as corporations, in which the concentration of funds on expensive means is more noticeable.

Promising directions for this research area are developments regarding the use of various electronic gadgets for data processing, work for warehouse operations, elements of social media engagement, etc.

7. Conclusions

1. It should be noted that the information age is fundamentally different from the industrial system at all levels. Information and knowledge have always served power and production. But only when new information and communication technologies enabled humanity to continuously increase knowledge and experience, the production potential became unprecedented, and the connection between intellectual activity and material production became extremely close. Thus, reducing the gap between social and economic development through technological innovations, information management, and uniform global development is one of the most pressing issues of the 21st century. The qualitative results of our study on digitalization are an understanding of the impact of its manifestations on economic development (the evolution of productive forces and production relations, which is actively manifested in motor transport enterprises). The application of digital technologies has entered all domains of economic life and all components of economic systems: from the use of AI in the production of material and spiritual goods to electronic document management within the UN and the EU. These issues are considered by the economics of digitalization.

2. The use of management tools is aimed at promoting the optimization of the organizational structure of management, building economic and mathematical models of development, forecasting transportation and investments, as well as ensuring interfunctional coordination focused on demand and flexible response to market changes. Thus, the transport enterprise management system appears as a key tool for the efficiency and sustainability of its functioning, which, due to its comprehensive nature, ensures balanced development, increased competitiveness and adaptation to the challenges of the modern market. The qualitative principles of the enterprise management system depend on the impact of digitalization on the elements of the management system, which include, first of all, management functions (planning, organization, motivation, coordination and control). Thus, the transport enterprise management system can be considered an integrated organizational and economic mechanism that ensures the consistency of planning, organization, motivation, control, and regulatory and coordination influences. Its essence is the combination of various means of influence that form the integrity of managerial activities and are characterized by a multi-component structure.

3. Ukrainian transport enterprises operate in a highly turbulent environment, formed by a combination of military threats, global crises, and market instability. This turbulence has a dual nature: on the one hand, it generates large-scale risks and losses, on the other hand, it opens up new opportunities for integration into European transport networks and transformation of business models. Survival and further development of the transport industry are possible only through adaptation strategies. Among them, the most significant are digitalization of logistics processes, integration into TEN-T and the European transport space, diversification of routes and sources of financing, as well as the introduction of innovative business models. A systematic approach to managing transport enterprises makes it possible to minimize the consequences of destruction and economic shocks. Its implementation involves a combination of short-term anti-crisis solutions (restoration of critical infrastructure, ensuring basic resilience) and long-term strategies (modernization according to EU standards, greening and digitalization). In the perspective of post-war recovery, it is the complexity of reforms and the involvement of international support, as the main factors of qualitative and quantitative transformations, that will determine the ability of the Ukrainian transport industry to become the core of European-Asian logistics flows and a key factor in the economic stability of the state.

4. The conditions for the development of the digitalization of the transport enterprise management system (using the example of TOV TRANSPORT & Co.) ensure that all company processes can be divided into main, auxiliary, and management. The main process is the process that results in the creation of a service, which should be affected by digitalization in the enterprise management system. A multifactor analysis was conducted, which showed that the impact of the main indicators of digitalization on the profitability of a transport enterprise is not decisive and resources should be accumulated for a decisive impact on the economic efficiency of the company's activities. When they are implemented, the value of the service increases. That is, the process of organizing transportation services itself is the main process. They differ in the types of transportation and the INCOTERMS conditions under which transportation is organized. Auxiliary processes, in particular regarding digitalization, contribute to the implementation of the main processes. Auxiliary processes are subject to digitalization to a greater extent than all other processes in enterprise management. All auxiliary processes at TOV TRANSPORT & Co are focused on automation and the use of AI. Management processes involve coordinating all activities of TOV TRANSPORT & Co, ensuring the result and its improvement.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study, as well as the results reported in this paper.

Funding

The study was conducted without financial support.

Data availability

All data are available, either in numerical or graphical form, in the main text of the manuscript.

Use of artificial intelligence

When preparing this manuscript, artificial intelligence tools ChatGPT, model GPT-5.1 (OpenAI) were used.

The use of AI concerned individual auxiliary stages of work on the text and did not affect the substantive part of the study.

AI tools were used in the following parts of the text: individual paragraphs in Introduction – for stylistic improvement of formulations; part of the generalizations in section 1 – analysis of literary data and statement of the problem; editorial improvements in section 5. 1 – determining the features of the digitalization economy; clarification of the logic of the presentation in the conclusions to the study. All statistical data, formulas, regression analysis, tables, and factual conclusions were compiled by the authors independently without the use of AI.

The AI tool was used exclusively as an auxiliary editorial tool for: stylistic improvement of individual sentences and transitions between paragraphs; improving the readability of the text and the logical coherence of descriptive fragments; clarifying the wording of definitions (without creating new concepts or theories); preliminary structuring of large text blocks; suggestions for the wording of individual explanatory paragraphs, which were subsequently fully checked and corrected by the authors.

The AI did not generate scientific results, did not perform calculations, and did not participate in the creation of empirical analysis.

Each fragment of text created or edited with the participation of the AI tool was fully checked for compliance with factual data and research materials; checked with original sources, statistics, and literature; manually edited for compliance with transport industry terminology; assessed for compliance with academic standards, research logic, and publication style.

The authors confirm that no information suggested by the AI was included without checking and correction.

The use of AI tools did not affect the scientific results and conclusions. All theoretical provisions, description of economic categories, analytical part, multivariate regression data, tables, graphs, and final conclusions were developed exclusively by the authors based on their own research and are not the result of AI activities.

AI only contributed to improving the stylistic quality of the presentation; logical structuring of descriptive fragments; optimization of editing time.

Thus, AI did not form conclusions, did not determine the interpretation of the results and did not influence the authors' scientific position.

Authors' contributions

Yuliia Remyha: conceptualization, validation, writing – original draft; **Tetiana Ostapenko:** methodology, formal analysis, investigation, writing – original draft; **Tetiana Posnova:** resources, data curation, writing – original draft; **Oleksandr Ponomarov**: visualization, writing – original draft; **Denys Shcherbatykh**: writing – review & editing; **Iryna Hrashchenko**: software, supervision, project administration, funding acquisition.

References

1. Buriak, A., Maslii, O. (2025). Minimization of digital risks and threats to the economic security of the state through the use of generative artificial intelligence. Eastern-European Journal of Enterprise Technologies, 4 (13 (136)), 17–25. https://doi.org/10.15587/1729-4061.2025.336640
2. Prokhorova, V., Budanov, O., Budanov, M., Slastianykova, K. (2025). Building a consolidated model of digital coherence for managing the information potential at power enterprises. Eastern-European Journal of Enterprise Technologies, 4 (13 (136)), 58–69. https://doi.org/10.15587/1729-4061.2025.336641
3. Radynskyy, S., Ratynskiy, V., Krupka, A., Shpylyk, S., Pohrishchuk, H., Dobizha, N. et al. (2025). Innovative approaches to project financing management in the context of digitalization: micro- and macro-aspects. Eastern-European Journal of Enterprise Technologies, 3 (13 (135)), 87–95. https://doi.org/10.15587/1729-4061.2025.333507
4. Soetikno, H. W., Maupa, H., Cahyadi, H. (2025). Digital entrepreneurship decisions in Indonesian women-led SMEs: an integrated SEM of transformation, skills, innovation, and behavioral intention. Eastern-European Journal of Enterprise Technologies, 3 (13 (135)), 60–67. https://doi.org/10.15587/1729-4061.2025.330229
5. Babyna, O. Ye. (2017). Metodoloho-praktychni osnovy formuvannia ta realizatsiyi potentsialu transportnykh pidpryiemstv. Kyiv: Natsionalnyi transportnyi universytet, 46. Available at: http://diser.ntu.edu.ua/Babina_aref.pdf
6. Pakhota, N. (2020). Organizational culture management of transport enterprises. Efektyvna Ekonomika, 8. https://doi.org/10.32702/2307-2105-2020.8.75
7. Kernychnyi, B., Radynskyy, S. (2021). Analysis of the current state and trends of the development of transport and logistical service of domestic industrial enterprises. Galic'kij Ekonomičnij Visnik, 69 (2), 83–94. https://doi.org/10.33108/galicianvisnyk_tntu2021.02.083

8. Dykan, V. L., Yelahin, Yu. V. (2015). Information technology improving efficiency passenger traffic. The bulletin of transport and industry economics, 52. https://doi.org/10.18664/338.47:338.45.v0i52.61666
9. Osypova, Y. L. (2022). Adaptive Management of Innovative Development of Transport Enterprises. Business Inform, 1 (528), 383–390. https://doi.org/10.32983/2222-4459-2022-1-383-390
10. Yanovska, V., Król, M., Pittman, R. (2025). The logistics of grain exports from wartime Ukraine: What are the highest priority areas to Address? Transportation Research Interdisciplinary Perspectives, 30, 101363. https://doi.org/10.1016/j.trip.2025.101363
11. Fernandes, G., Teixeira, P., Santos, T. A. (2023). The impact of the Ukraine conflict in internal and external grain transport costs. Transportation Research Interdisciplinary Perspectives, 19, 100803. https://doi.org/10.1016/j.trip.2023.100803
12. Solidarity Lanes: latest figures (2025). European Commission. Available at: https://transport.ec.europa.eu/news-events/news/solidarity-lanes-latest-figures-july-2025-2025-08-20_en
13. Rossolov, O., Potaman, N., Levchenko, O., Susilo, Y. O. (2025). Urban mobility under armed conflict: shifts in mode preferences and public transport fare behaviors. European Transport Research Review, 17 (1). https://doi.org/10.1186/s12544-025-00714-z
14. Enhancing Resilience by Boosting Digital Business Transformation in Ukraine (2024). OECD. https://doi.org/10.1787/4b13b0bb-en
15. Russian drones target Ukraine's railway network (2025). Financial Times. Available at: https://www.ft.com/content/de5a13d4-22f9-4409-8fc3-2842d4c37dee
16. Melnyk, M., Leshchukh, I., Prytula, K., Ivaniuk, U., Ohinok, S. (2024). Logistics potential to ensure the resilience of the Ukrainian economic system facing global challenges. Problems and Perspectives in Management, 22 (2), 399–418. https://doi.org/10.21511/ppm.22(2).2024.31
17. EU celebrates two years of Solidarity Lanes – more than 136 million tonnes of goods exported. EU Neighbourseast. Available at: https://euneighbourseast.eu/news/latest-news/eu-celebrates-two-years-of-solidarity-lanes-more-than-136-million-tonnes-of-goods-exported/
18. Ukraine Grain Transportation, June 2025 (2025). U.S. Department of Agriculture, Agricultural Marketing Service. https://doi.org/10.9752/ts260.06-2025
19. Ukraine's Transport and Logistics System (2025). World Bank. Available at: https://documents1.worldbank.org/curated/en/099061725033525342/pdf/P502442-346a4fd3-882f-46ca-95c9-ce90c0a71619.pdf
20. Jagtap, S., Trollman, H., Trollman, F., Garcia-Garcia, G., Parra-López, C., Duong, L. et al. (2022). The Russia-Ukraine Conflict: Its Implications for the Global Food Supply Chains. Foods, 11 (14), 2098. https://doi.org/10.3390/foods11142098
21. Rabinovych, M. (2024). EU external differentiated integration as a crisis response tool? Evidence from Ukraine. West European Politics, 48 (5), 1216–1241. https://doi.org/10.1080/01402382.2024.2401246
22. Martin, B. P., Faure, M.-A., Cremaschini, F., Ducruet, C. (2025). Shipping trade and geopolitical turmoil. Journal of Transport Geography, 128, 104342. https://doi.org/10.1016/j.jtrangeo.2025.104342
23. EU-Ukraine Solidarity Lanes (2024). European Commission. Available at: https://commission.europa.eu/topics/eu-solidarity-ukraine/eu-assistance-ukraine/eu-ukraine-solidarity-lanes_en
24. ITF Transport Outlook 2023 (2023). In ITF Transport Outlook. OECD Publishing. https://doi.org/10.1787/b6cc9ad5-en