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**Komar Andrii**
Postgraduate student at the Department of Economics, Finance and Accounting,
Private Higher Educational Institution "European University"
ORCID: https://orcid.org/0009-0000-9881-5643

**Remyha Yuliia**
Ph.D. in Economics, Associate Professor,
Head of the Department of Management and Logistics,
Private Higher Educational Institution "European University"
ORCID: https://orcid.org/0000-0001-7162-5081

# DIGITALIZATION OF MANAGEMENT SOLUTIONS IN THE TRANSPORT INDUSTRY

*The article explores modern approaches to digitalization and digital management of management solutions in the transport industry under the conditions of global digital transformation. Special attention is paid to the role of the Internet of Things (IoT), artificial intelligence (AI), Big Data and automation in increasing the efficiency, safety and sustainability of transport and logistic systems. The main areas of digital technologies application in the transport industry are analyzed, including logistics processes and automation of management functions. Key directions of digital transformation are identified, such as infrastructure digitalization, process automation and development of intelligent decision-support systems. It is concluded that digital management is a strategic tool for enhancing competitiveness, optimizing costs and improving the quality of transport services.*

***Keywords:*** *digitalization, digital management, management solutions, transport industry, Internet of Things (IoT), artificial intelligence, logistics, automation.*

**Комар А.М., Ремига Ю.С.**
Приватний вищий навчальний заклад «Європейський університет»

# ЦИФРОВІЗАЦІЯ УПРАВЛІНСЬКИХ РІШЕНЬ У ТРАНСПОРТНІЙ ГАЛУЗІ

*У статті досліджено сучасні підходи до цифровізації управлінських рішень у транспортній галузі в умовах інтенсивного розвитку ІТ та глобальної цифрової трансформації економіки. Актуальність дослідження зумовлена необхідністю підвищення ефективності управління транспортними підприємствами, забезпечення безпеки перевезень і стійкості транспортно-логістичних систем в умовах зростання конкуренції та технологічних змін. Метою статті є обґрунтування ролі цифрових технологій у формуванні системи цифрового управління та підвищенні результативності управлінських рішень у транспортній галузі. Методологічну основу дослідження становлять системний і структурно-функціональний підходи, методи наукового узагальнення, порівняльного аналізу. У роботі обґрунтовано роль цифрових технологій, зокрема IoT, Big Data, ШІ та AIC, у підвищенні ефективності, безпеки та стійкості функціонування транспортно-логістичних систем. Проаналізовано основні напрями застосування цифрових рішень у різних сегментах транспорту, наведено приклади їх практичного використання та оцінено результати впровадження з позицій оптимізації витрат, якості послуг і швидкості прийняття управлінських рішень. Визначено ключові напрями цифрової трансформації транспортної галузі, зокрема цифровізацію транспортної інфраструктури, автоматизацію управлінських функцій, роботизацію виробничих процесів і розвиток систем автономного керування транспортними засобами. Узагальнено чинники переходу транспортних підприємств до цифрового управління, серед яких оперативність прийняття рішень, мотивація персоналу, ефективний контроль діяльності, підвищення рівня безпеки руху. Зроблено висновок, що цифрове управління є стратегічним напрямом розвитку транспортної галузі, який забезпечує адаптацію підприємств до динамічних змін ринкового середовища та формування інноваційних бізнес-моделей. Результати дослідження можуть бути використані в практиці управління транспортних компаній та в подальших наукових дослідженнях з проблем цифрової трансформації транспорту.*

***Ключові слова:*** *цифровізація, цифрове управління, управлінські рішення, транспортна галузь, інтернет речей (IoT), штучний інтелект, логістика, автоматизація.*

**Problem statement.** In the context of intensive development of information technologies and comprehensive digitalization, the global economic system is undergoing profound structural changes. Digital innovations have a significant impact on the functioning and evolution of various sectors of the economy and social life. One of the key areas in which large-scale transformation processes are taking place is the transport and logistics industry. Its development is largely due to the integration of computer technologies and artificial intelligence methods, which contributes to increasing the efficiency, level of safety and sustainability of transport systems and logistics processes. Under modern conditions, transport enterprises are forced to respond promptly to dynamic changes in the external environment, make sound management decisions, ensure the proper level of transportation safety and rational use of resource potential. In this regard, the introduction of digital technologies into the management system acquires the status of not only a current trend, but also a

necessary prerequisite for ensuring the competitiveness and sustainable development of transport enterprises.

**Analysis of recent research and publications.** The issue of digitalization at the current stage of development of economic science occupies one of the leading places in scientific research. Within this topic, separate areas of scientific analysis have been formed, in particular, e-government, robotization and the application of artificial intelligence technologies, as well as the introduction of innovative technologies into production processes. In the latest scientific publications, more and more attention is paid to the issues of digital management, digital transformation of enterprises and the use of digital management tools. A significant contribution to the study of this issue was made by domestic scientists, including A.Demchenko and V.Bondarenko [1], T.Gaykova, V.Zagoryansky and A.Leontovych [2], M.Semykina and I.Yaroshenko [3], I.Tsmots and G.Nazarkevych [4], S.Kovalchuk and V.Ponomarenko [5], O.Ptashchenko and O.Sokhatska [6], V.Lisitsa and O.Mykhailenko [7], T.Charkina and V.Zadoya [8], V.Yanovska and A.Medina [9]. and others. At the same time, the issues of digitalization of management decisions in the transport industry remain insufficiently studied and require further thorough scientific research.

**Statement of the task.** The goal is to investigate modern approaches to the digitalization of management decisions in the transport industry.

**Presentation of the main material of the study.** The concept of digitalization is multifaceted and covers a wide range of processes, therefore, without a detailed analysis of all forms of its manifestation, it is advisable to focus on the specifics of this phenomenon in the transport sector [1]. In this context, the digitalization of transport is considered as a complex and large-scale process of implementing the results of digital technical and technological development in the functioning of transport systems. At the same time, scientific research lacks unified approaches to assessing the depth and scale of economic transformations caused by digitalization, as well as to determining the mechanisms and pace of implementation of digital technologies at both the managerial and technological levels [3; 12].

A characteristic feature of digitalization processes in the transport sector is their uneven development in individual areas, despite the presence of significant potential demand for digital solutions. Under such conditions, the active use of digital technologies is one of the most promising tools for increasing the economic efficiency of the functioning of the transport sector. The scientific literature identifies a number of the most common areas of application of digital technologies in transport [2].

The transport industry is one of the types of economic activity that is most significantly affected by the processes of digital transformation. It is advisable to consider this impact in two dimensions [9]: first, as relatively superficial changes that manifest themselves in the implementation of technological solutions that have already been tested in other sectors of the economy, in particular technologies for processing large data sets and intelligent systems; second, as deep transformations that occur directly in the transport infrastructure and relate to changes in the technical and economic principles of its functioning are shown in Table 1.

Detailed examples of the application of digital technologies in the transport sector are shown in Table 2.

In this context, intelligent transport systems (ITS) are the leading trend of modern technological development of the industry. At the same time, the digitalization of the transport sector in its deep dimension involves the transformation of basic production processes and management mechanisms. At the current stage, four key areas of digital transformation of the transport industry are distinguished: digitalization of transport infrastructure and logistics chains, in particular warehousing and service centers; robotization of production processes; comprehensive automation, including management

Table 1

**Areas of application of digital technologies in the transport industry**

| Direction | Digital technologies | Application examples |
|---|---|---|
| Traffic flow management | Big Data, AI, IoT | Intelligent traffic lights, traffic jam prediction |
| Logistics and freight transportation | GPS, ERP, blockchain | Cargo tracking, route optimization |
| Passenger transportation | Mobile applications, AI | Electronic tickets, personalized itineraries |
| Traffic safety | Computer vision, sensors | Driver assistance systems, video monitoring |
| Maintenance | Predictive analytics, IoT | Forecasting transport breakdowns |
| Environmental efficiency | Data analytics, AI | Reducing emissions, optimizing fuel consumption |
| Administrative management | Digital platforms, CRM | Electronic document management, personnel management |

*Source: based on [10–14]*

Table 2

**Examples of the application of digital technologies in the transport sector**

| Transport sector | Digital technology | Application example | Implementation result |
|---|---|---|---|
| Road transport | IoT, GPS | Real-time transport monitoring systems | Reduced fuel consumption, increased control |
| Railway transport | Big Data, AI | Forecasting technical failures | Improving security and reliability |
| Air transport | AI, automated systems | Flight route optimization | Time and cost reduction |
| City transport | Smart systems, mobile applications | Electronic tickets, smart stops | Improving service for passengers |
| Logistics and freight transportation | ERP, blockchain | Supply chain tracking | Transparency and risk reduction |
| Sea transport | AIS, digital platforms | Port logistics management | Increasing throughput |

*Source: based on [10–14]*

functions; implementation of autonomous vehicle control systems [11; 13].

The digitalization of transport infrastructure consists in involving each stage of the logistics chain, as well as each vehicle, in a single digital environment, which involves their digital identification on the Internet and functioning under the control of specialized software.

The involvement of transport infrastructure in the digital environment creates opportunities for comprehensive management of transport flows in real time, optimization of aggregate and unproductive costs, as well as increasing the level of predictability of the functioning of the transport system as a whole. An example of the implementation of such an approach is equipping sea containers with electronic identifiers, which provides continuous monitoring of the movement of each unit of cargo.

Robotization of production processes in the transport industry is being implemented at a dynamic pace, however, some of the most labor-intensive segments, in particular warehousing (especially cargo packing and assembly operations) and vehicle maintenance, continue to require significant manual labor.

Automation of management processes in the transport sector has a long history of development, since this industry was one of the first where management functions began to be implemented using automated systems. The intensity and speed of modern transport flows create a situation in which making effective management decisions without the use of digital tools is accompanied by a high risk of critical errors.

The implementation of autonomous vehicle control systems from a technological point of view has been underway for a long time, primarily in civil aviation and maritime cargo transportation. At the same time, their large-scale application in most countries is hampered by current regulatory and legal restrictions, as a result of which mainly experimental projects are currently being implemented, in particular in the field of public transport (for example, unmanned buses) [5].

In general, digitalization as a leading trend in the technological development of the transport industry was identified in the early stages of the formation of electronic computing. Since then, a significant number of projects have been implemented with the participation of both state institutions and private companies. At the same time, the use of automated transport systems still remains the subject of scientific and public debate, since there is no established consensus in society regarding the consequences of their implementation.

The main threats and risks considered as direct consequences of the automation of the transport sector include the potential simultaneous release of a significant number of drivers with subsequent limited opportunities for their employment in their profession, the complexity of determining the degree of liability in the event of insurance accidents, as well as the risks of technical software failures and loss of control over controlled vehicles.

At the same time, most researchers recognize the significant advantages of implementing automated and autonomous technologies, including increasing the overall efficiency of the transport system, reducing fuel costs, increasing the throughput capacity of transport infrastructure, reducing the level of accidents, reducing the number of victims and the volume of damaged goods, optimizing personnel costs, reducing vehicle downtime, and minimizing the impact of the human factor [9].

An important modern trend is the transformation of artificial intelligence technologies into general-purpose technologies for the transport industry. In parallel, the level of technological involvement of transport service users is increasing due to the mass distribution of mobile devices with Internet access, which makes it possible to build fundamentally new models of interaction between transport systems and consumers. The emergence of platform services, in particular, such as Uber, and the spread of the concept of “uberization” have led to fundamental changes in the basic principles of organizing and providing transport services [8].

It is worth noting that the digital transformation of the transport system covers not only technological but also economic aspects. The introduction of automated solutions and modern analytical tools creates the prerequisites for rationalizing carriers' costs, increasing the level of rolling stock utilization and reducing operating costs. Along with this, digital services contribute to the increase in the quality of transport services, make it possible to flexibly adjust the route network in accordance with the actual needs of the population and ensure wider accessibility of transportation. The digitalization of the transport industry creates conditions for stable and continuous operation of routes, optimization of traffic schedules and increased comfort of passenger service. The use of environmentally friendly and technologically modern modes of transport can change the established ideas about public transport, increase its attractiveness and form it as a priority mode of transportation for city residents. In addition, digital tools stimulate the development of multimodal transportation, within which different modes of transport are integrated into a single logistics system. This approach ensures the formation of an effective transport infrastructure that meets the current needs of society and contributes to the socio-economic development of regions.

Digital management is gaining particular importance for the transport industry in the context of increasing dynamism and complexity of logistics chains, increased integration with global transport systems, as well as the need to comply with environmental safety requirements. The use of digital technologies provides transport enterprises with the opportunity not only to effectively adapt to new market challenges, but also to form innovative business models based on the use of analytical tools, predictive methods and automated management solutions.

In the scientific sense, digital management involves the integrated use of modern information systems, automated software complexes, big data processing technologies, the Internet of Things (IoT) and artificial intelligence tools in order to increase the efficiency of management, monitoring and control of the enterprise. The implementation of digital solutions provides transport enterprises with the ability to quickly respond to changes in the market environment, automate standard operating processes, optimize costs, improve the quality of service provision and ensure transparency of management procedures [15].

Right now, the transition to digital management is becoming an urgent necessity for several key reasons are shown in Table 3.

Detailing the key factors of the transition of transport enterprises to digital management [6]:

Table 3

**The main factors of the transition to digitalization of management solutions in transport**

| Factor | Characteristic |
|---|---|
| Promptness of decision-making | Providing access to relevant and reliable information in real time, reducing the time for analysis and selection of management decisions, and reducing the risk of errors. |
| Staff motivation | Reducing routine workload, developing digital competencies of employees, increasing transparency in assessing work results, and creating a culture of continuous learning. |
| Effective activity control | Comprehensive monitoring of production, financial and technical indicators in real time, increasing transparency and manageability of business processes. |
| Improving traffic safety | Operational control of the technical condition of vehicles and infrastructure, minimizing the impact of the human factor and reducing the risks of emergency situations. |
| Increasing competitiveness | Adaptation of business processes to market changes, optimization of costs, reduction of order fulfillment times and improvement of the quality of transport services. |

*Source: based on [15]*

1. Efficiency of management decision-making.

In conditions of high dynamics of development of the transport industry and intensification of competition, the speed of making management decisions acquires strategic importance. Digital management systems provide continuous access to complete, up-to-date and reliable information in real time, which allows to significantly reduce the time spent on analyzing the current situation, assessing possible consequences and choosing optimal management alternatives. Automation of data collection, processing and visualization processes reduces the likelihood of errors caused by the influence of the human factor and promotes decision-making based on objective indicators and analytical models. This, in turn, increases the overall efficiency of transport enterprises and ensures their ability to respond promptly to changes in the market environment, technical condition of infrastructure facilities and logistics conditions.

2. Increasing staff motivation.

An important factor in the digital transformation of management in the transport sector is the stimulation of personnel for productive and high-quality work. The introduction of digital technologies transforms the nature of work, reducing the share of routine operations and creating conditions for the development of digital competencies of employees. Process automation contributes to increasing the transparency of task performance control and objectivity of work results assessment, which, in turn, strengthens trust between personnel and management, increases responsibility, discipline and interest in improving professional qualifications. Digital management systems also create the prerequisites for the development of a culture of continuous professional learning, which is critically important for the sustainable functioning of transport enterprises in the face of technological and market changes.

3. Ensuring effective control of activities.

With the complexity of transport systems and logistics processes, effective control of the enterprise's activities becomes one of the key prerequisites for its stable development. The use of digital management systems allows for comprehensive monitoring of production, financial, economic and technical indicators in real time, which significantly increases the transparency and manageability of business processes.

4. Increasing the level of traffic safety.

Digital monitoring systems, in particular in the field of railway transport, provide operational tracking of the technical condition of locomotives, wagons, track infrastructure elements and signaling systems in real time. The use of such technologies allows minimizing the impact of the human factor on operational processes and significantly reducing the likelihood of accidents and emergencies.

5. Increasing the competitiveness of transport enterprises.

In modern market conditions, the intensification of competition between transport operators necessitates the constant improvement of the quality of transport services, the reliability of logistics schemes and the economic efficiency of transportation. In this context, the implementation of digital management systems is one of the key tools for ensuring the competitive advantages of transport enterprises. Digital technologies allow you to quickly adapt business processes to changes in the market situation, reduce order fulfillment times, optimize costs and improve the level of customer service. The use of analytical platforms and forecasting systems expands the capabilities of enterprises to respond to market demands in a timely manner, diversify the range of services and ensure stable positioning in conditions of fierce inter-industry competition.

**Conclusions.** The study allows us to conclude that the digitalization of management decisions is a determining factor in the transformation and sustainable development of the transport industry in the conditions of the modern economy. The integration of digital technologies, in particular the Internet of Things (IoT), big data (Big Data), artificial intelligence and automated information systems, significantly changes traditional approaches to the organization of transport and logistics processes, increasing their efficiency, safety and manageability.

It was established that the digitalization of transport is multidimensional and manifests itself at both the technological and managerial levels. It covers the management of transport flows, logistics, passenger and freight transportation, maintenance, traffic safety, environmental efficiency and administrative management. The use of digital solutions in these areas contributes to the optimization of costs, reduction of downtime, improvement of the quality of transport services and reduction of the negative impact of the human factor.

It has been proven that the transition to digital management in the transport industry is due to a number of key factors, among which the efficiency of management decision-making, increased staff motivation, ensuring effective control of activities, increasing the level of traffic safety and strengthening the competitiveness of transport

enterprises play a special role. Digital management systems create conditions for making informed decisions based on current data in real time and ensure transparency of management processes.

At the same time, it has been established that the processes of digital transformation of transport are accompanied by certain risks and challenges, in particular the social consequences of automation, regulatory and legal restrictions on the introduction of autonomous vehicles, as well as the threats of technical failures and cybersecurity. This necessitates a comprehensive approach to digitalization, which combines technological innovations, improved regulatory regulation and the development of human capital.

Therefore, digital management should be considered not as a separate tool for modernization, but as a strategic direction for the development of the transport industry, ensuring its adaptation to global technological and market changes. Further scientific research should be directed towards developing methodological approaches to assessing the effectiveness of digital management solutions, as well as studying the practical aspects of their implementation, taking into account industry specifics and national conditions.

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