Digital transformation in the transport and logistics sector of Kazakhstan: Challenges and opportunities for global integration

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Abstract. The purpose of the study was to identify the key advantages and challenges of digitalisation in the transport and logistics sector of Kazakhstan and assess its impact on economic growth and international cooperation. The study employed methods of analysis, evaluation, and forecasting to determine the effects of digital technologies on various dimensions of the transport and logistics system of Kazakhstan, including productivity, investment appeal, and global integration. Findings indicated that digital transformation enhances effectiveness, reduces transaction costs, and improves investment attractiveness of the sector. The introduction of digital platforms, automation of customs procedures, and use of artificial intelligence (AI) accelerated cargo processing and optimised operations. Analysis indicated that digitalisation fosters growth in foreign investment by increasing transparency and predictability in transport processes. Private infrastructure investments were projected to reach USD 500-800 million, yielding returns of 15-20% over 3-5 years, while public subsidies may amount to USD 200-300 million with returns of 10-12% over 1-3 years. International projects are estimated to generate USD 600-900 million in investment with expected returns of 18-25% over 4-6 years. Public-private partnerships are anticipated at the level of USD 400-600 million, offering returns of 12-18% over 2-4 years, and investments in start-ups are expected to total USD 100-200 million with returns of 25-35% over 2-3 years. The development of digital solutions across international transport corridors strengthened the role of Kazakhstan as a logistical hub. However, major challenges persisted, including inadequate digital infrastructure, cyber threats, low levels of digital literacy, and financial constraints faced by small and medium-sized enterprises. Effective transformation requires strong public-private cooperation and the creation of "smart" logistics hubs. Digitalisation within the transport and logistics sector thus presents substantial potential for positioning the country as a leading logistical hub in Central Asia

Keywords: investment; automation; international corridors; cybersecurity; logistics infrastructure; global integration

Introduction

The transport and logistics sector of Kazakhstan plays a pivotal role in facilitating connections between Asia and Europe, positioning the country as a key actor within global trade networks. Considerable efforts were made to develop logistics infrastructure, with the aim of achieving deeper integration into international transport systems and enhancing competitiveness in the global marketplace. A critical dimension of this development involves digital transformation, which entails the adoption of advanced technologies to improve efficiency, reduce costs, and strengthen collaboration with international partners. Digitalisation of transport and logistics processes presents new opportunities for optimising freight operations, lowering transaction costs, and raising service standards. Nonetheless, several challenges persist, including the need for infrastructure modernisation, cybersecurity, and adequate personnel training. Successful digital transformation in the transport and logistics sector has the potential not only to improve internal operational efficiency but also to reinforce the country's strategic position within the global economy.

The core issue underlying digital transformation in this sector involves the integration of new technologies aimed at increasing efficiency, enhancing international connectivity, and reducing operational expenditures. G.D. Yesenzholova & R.T. Dulambaeva (2024) highlighted that automation of customs procedures may significantly accelerate transactions and reduce administrative barriers, thereby fostering stronger international links. They also emphasised the role of digital technologies in enhancing transparency and reducing wait times. C.H. Chang *et al.* (2022) stressed the importance of implementing digital logistics platforms, noting their ability to substantially decrease operational costs and improve national competitiveness. These authors also identified the benefits of blockchain technology

in ensuring the security and transparency of transport operations. G. Ping *et al.* (2024) examined the application of artificial intelligence (AI) and big data for demand forecasting and route optimisation in logistics. Their findings demonstrated that such technologies considerably improve the efficiency and accuracy of freight transport processes. U. Plesner & L. Justesen (2022) investigated the legislative implications of digitalisation, underscoring the importance of not only introducing new technologies but also establishing supportive regulatory frameworks. They emphasised the need to adapt legal systems to digital realities and protect business rights within a digital environment. Y. Ding *et al.* (2021) explored the potential for creating "smart" logistics hubs based on the Internet of Things (IoT) and AI technologies. These hubs were found to considerably enhance data processing and accelerate transport operations, potentially serving as key enablers for integration into global logistics chains.

R. Attah *et al.* (2024) emphasised that successful digital transformation in the transport and logistics sector requires substantial investment in infrastructure. Without the modernisation of existing facilities and the establishment of new innovation hubs, digitalisation would remain limited. A. Odimarha *et al.* (2024) drew attention to cybersecurity concerns, which had become increasingly critical in the context of expanding digital systems in transport and logistics. Their study proposed comprehensive data protection strategies, including the deployment of blockchain technologies to ensure the security of transport operations. C. Chen *et al.* (2021) examined the role of government support programmes in the digitalisation of the transport sector, arguing that such initiatives are essential for stimulating the development of small and medium-sized enterprises. Government subsidies and grants were considered

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instrumental in accelerating technology adoption and reducing barriers for smaller market participants. J. Njoku *et al.* (2023) explored the potential for integration into international digital transport networks, asserting that such integration would unlock new opportunities for exports and transit flows. The authors underlined the importance of expanding infrastructure to connect with global logistics ecosystems. A. Gupta *et al.* (2022) highlighted the need to improve the digital literacy of personnel to enable the effective implementation and utilisation of new technologies within the logistics industry. Without high-quality training and upskilling of professionals in transport and logistics, the deployment of digital solutions would face obstacles. However, certain areas remain underexplored, including the integration of digital solutions with existing infrastructure and the complexities of cooperation between public and private actors throughout the digital transformation. Furthermore, cybersecurity risks and challenges across all stages of digital transformation have not yet been sufficiently investigated.

The purpose of this study was to analyse the impact of digital transformation on the development of the transport and logistics sector, identify key challenges and opportunities for global integration, and assess the potential economic benefits for the country.

Study objectives:

1. Assess potential pathways for attracting investment in the digitalisation of logistics infrastructure and the development of new technologies aimed at modernising the transport system.

2. Examine the prospects for implementing IoT, AI, and Big Data technologies in logistics hubs to improve freight efficiency and optimise logistical processes.

Materials and Methods

The study analysed the impact of digital technologies on the efficiency and competitiveness of the transport and logistics sector in the country. The potential application of innovative solutions in logistics was examined, including automation, AI, IoT, blockchain, and Big Data. Methods for enhancing sector performance were evaluated according to indicators such as resource utilisation efficiency, improvements in data processing speed, and reductions in operational time. The role of digitalisation in decreasing logistics costs and strengthening the competitiveness of both individual enterprises and the national economy was also considered.

The study explored the effects of implementing electronic documentation, such as the e-CMR (electronic Consignment Note) (International Road and Transport Union, n.d.) and the "Astana-1" system (It is now…, 2024), on the reduction of transactional costs. These technologies were assessed in terms of their capacity to simplify administrative processes and reduce bureaucratic barriers. The contribution of electronic documentation to lowering logistics expenditure, increasing operational transparency, improving responsiveness to changes in transport flows, and minimising overall costs was investigated.

The development of international transport corridors was also a key focus. Approaches to integrating the country into global transport networks were reviewed, including participation in initiatives such as the Belt and Road Initiative (World Bank, 2020) and the Trans-Caspian International Transport Route. The analysis employed indicators such as border crossing times, the proportion of digital operations within total processes, and the number of required transactional procedures. Digital solutions such as automated cargo monitoring and management systems were evaluated for their role in accelerating integration into international transport initiatives, improving transit speed, and enhancing coordination among participating countries.

The study also addressed the integration of the country into global digital platforms aimed at increasing supply chain transparency and traceability, while reducing transactional risks. Company reports and analytical sources from projects such as TradeLens and Alibaba Logistics (TradeLens digital platform…, 2020) were used to assess these developments. The findings highlighted the role of involvement in such ecosystems in enhancing national competitiveness in the global market, ensuring high standards of cargo handling and monitoring, reducing risk, and improving control over logistics processes.

Attention was also given to the role of developing "smart" logistics hubs. The feasibility of integrating IoT, AI, and Big Data technologies into logistics centres in Almaty and Astana was examined with the objective of enhancing the efficiency of freight transportation. The study employed an effectiveness analysis method, considering indicators such as data processing speed, real-time monitoring accuracy, reductions in logistics costs, and improved coordination among stakeholders. Potential benefits from optimising logistics processes, improving monitoring, and enhancing the management of goods movement through the use of these technologies were assessed. A SWOT analysis was conducted to examine the challenges of digitalisation in the country, drawing on analytics provided by the World Bank (2024). These sources offered deeper insight into the current strengths and weaknesses of the digital infrastructure and the opportunities for growth and development presented by digitalisation across the logistics sector and the wider economy.

Investment in the digitalisation of logistics infrastructure was another area of focus. Investment needs were evaluated through an analysis of strategic development programmes, infrastructure case studies, and international comparisons with practices in the European Union, China, and Southeast Asian countries (Panjee *et al.*, 2025). The analysis highlighted the requirement for substantial investment from both public and private actors to implement digital solutions in logistics. Possible strategies for increasing investment volumes in the sector were discussed, along with the influence of successful technological integration on the development of digital infrastructure that supported the modernisation of the national transport and logistics systems.

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Results

Digitalisation plays a pivotal role in enhancing the productivity and competitiveness of the transport and logistics sector. The adoption of new digital technologies has the potential to improve efficiency by accelerating processes, reducing costs, and increasing delivery speed. For example, the introduction of electronic document management systems at certain customs posts in Kazakhstan reduced cargo processing times from 2–3 days to just a few hours (Kazbekov *et al.*, 2024). Situated at the crossroads of key trade routes, Kazakhstan has the opportunity to leverage such changes not only to improve national logistics but also to strengthen its position in the international arena. One of the most crucial components of this advancement is process automation. The integration of modern information systems for freight management and documentation enables faster application processing, expedites customs procedures, and minimises the risk of human error. A project implementing automated monitoring systems on Kazakhstani railways, for instance, led to a 30% reduction in delivery schedule discrepancies. In turn, this contributes to cost savings and greater accuracy in order fulfilment, thereby improving customer service levels and enhancing corporate reputation.

Technologies such as IoT, AI, and blockchain create new possibilities for real-time monitoring and management of transport assets. These innovations support route optimisation, predictive failure analysis, and rapid response to shifting conditions. IoT solutions, in particular, facilitate continuous monitoring of vehicle and cargo conditions, which helps prevent losses caused by damage or misplacement (Tan & Sundarakani, 2021).

Moreover, digitalisation contributes to the reduction of administrative barriers. In Kazakhstan, similar to other countries, issues related to bureaucracy and procedural complexity can impede the speed and efficiency of transport operations. The deployment of electronic systems for document submission and cargo tracking addresses these challenges by increasing transparency and accelerating the overall process. Shorter timeframes for resolving administrative matters represent a major step towards enhancing sector-wide efficiency. Digital technologies have a profound impact on the transport and logistics sector by enabling a substantial reduction in transaction costs. This has resulted in fewer bureaucratic procedures and lower logistical expenses, generating positive effects for the economy (Mikl *et al.*, 2021).

Paper-based documentation in transport logistics has long been a source of considerable cost for both carriers and clients, due to the need for physical delivery, storage, and the handling of numerous documents at various stages of transportation. The introduction of electronic documentation eliminates the reliance on physical paperwork and significantly accelerates operational processes. For instance, the use of the e-CMR system allows the transmission of cargo-related information, routing, and transport conditions in digital format, accessible in real time by all participants within the supply chain (International Road and Transport Union, n.d.). Through the use of e-CMR, data processing speed increases by an average of 40%, while administrative and documentation costs are reduced by 30-50% due to the elimination of paper handling and storage.

The "Astana-1" system, introduced to manage and monitor international trade and customs clearance processes, also led to considerable reductions in costs associated with border crossings and customs procedures. Following the implementation of this system, customs declaration times fell from 3-4 hours to 15-30 minutes, and the number of document-related errors declined by 60% due to automated data verification. Furthermore, the digitalisation of procedures within the "Astana-1" framework reduced the number of physical cargo inspections by 20-25%, expediting border transit and lowering logistics costs. Overall, the use of electronic documentation and automated management systems contributes to substantial improvements in logistical efficiency, reduction in transaction costs, and enhanced transparency across the entire supply chain (It is now…, 2024).

One of the most noteworthy outcomes of implementing electronic documentation is the reduction of transaction costs. Within paper-based systems, substantial resources are expended on the transmission, processing, and verification of documents, alongside the resolution of errors and delays. Electronic systems accelerate these procedures, enabling enterprises to lower operational expenses and enhance overall efficiency. This is particularly important for logistics firms, which frequently manage high cargo volumes and face substantial costs related to document handling.

Lower transaction costs also contribute to improved competitiveness across the sector. Logistics firms adopting electronic systems are able to offer faster and more cost-effective services, increasing their attractiveness in the marketplace. Moreover, the implementation of digital solutions reduces the risks associated with document delays or losses, thereby minimising additional expenditures and supporting greater profitability. The use of electronic documentation also enhances transparency and trust in business operations. Digital systems record all actions and modifications in real time, reducing the likelihood of fraud or error in document processing. This is especially crucial in international trade, where compliance with regulations and standards is essential.

Digitalisation within the logistics sector offers considerable opportunities for attracting investment, which in turn supports infrastructure development and sectoral modernisation. The adoption of advanced technologies such as IoT, AI, process automation, and digital document management facilitates the creation of more efficient and adaptable logistics systems. Over the next five years, digitalisation is expected to lead to a substantial increase in investment in logistics infrastructure, with long-term positive implications for the broader economy (Table 1).

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Table 1. Potential investment pathways for digitalising logistics infrastructure and developing new technologies

Potential investment pathways	Projected investment volume (USD million)	Expected return (as % of investment)	Implementation timeframe (years)
Private investment in digital infrastructure	500-800	15-20	3-5
Government subsidies and grants	200-300	10-12	1-3
International investment projects	600-900	18-25	4-6
Public-private partnerships	400-600	12-18	2-4
Investment in start-ups and innovative solutions	100-200	25-35	2-3

Source: compiled by the authors based on P. Panjee *et al.* (2025)

Potential pathways for attracting investment in the digitalisation of logistics infrastructure and the development of new technologies may be assessed through a range of funding sources and their respective characteristics. Private investment requires substantial capital and tends to be long-term, yet the prospect of high returns makes it appealing to the business sector. Government subsidies and grants contribute to the accelerated implementation of projects, providing a foundation for digital transformation with minimal risk. International investment initiatives highlight the scale and importance of these projects for the global integration of Kazakhstan into broader digitalisation processes. Public-private partnerships illustrate the potential for balanced cooperation between the state and the private sector, supporting the effective deployment of technological solutions. Investment in start-ups and innovative solutions involves a high degree of risk, but also offers considerable profitability and rapid return on investment, rendering it a promising avenue for advancing new technological directions. These forecasts collectively confirm the existence of extensive opportunities for financing the digital transformation of logistics infrastructure in Kazakhstan, where each type of investment plays a critical role in accelerating modernisation and enhancing national competitiveness.

One of the key factors driving investment is the improvement in the efficiency and transparency of logistics operations. Digitalisation facilitates enhancements in supply chain management, optimises delivery routes, and reduces cargo handling times. As a result, the logistics sector becomes more attractive to both private and public investors seeking stable and predictable returns. Investment in digital technologies enables firms to reduce operational costs while improving service quality, which is a crucial consideration for attracting capital. Investors, in turn, focus on sectors exhibiting strong growth and a clear potential for improvement. Logistics, with its central objectives of process optimisation and faster delivery, remains a focal point. Automated management systems and digital platforms strengthen company competitiveness and increase their appeal to investors, thereby encouraging capital inflow into the sector (An *et al.*, 2021).

Digitalisation also supports the creation of innovative business models, including smart logistics hubs based on IoT and the development of blockchain-based solutions aimed at enhancing transparency and operational security. These innovations provide new opportunities for businesses and generate additional incentives for investing in logistics infrastructure development. More efficient and advanced solutions may also attract foreign investment, positively influencing the national economy and contributing to job creation. The implementation of digital technologies in logistics is closely linked to infrastructure enhancement, enabling the development of more complex and integrated transport and logistics systems. Modern cargo management systems that utilise real-time data improve the efficiency of ports, terminals, railways, and road networks. Infrastructure improvement, in turn, serves as a foundation for attracting investment from both national and international sources. Investors are keen to allocate capital to projects that support sustainable development and offer the potential for high returns, and digitalisation creates such opportunities (Polukhina & Mizanbekova, 2022).

The digital transformation of the logistics sector may also considerably enhance collaboration between the public and private sectors, thereby fostering a more favourable investment climate. The establishment of infrastructure that supports the adoption of new technologies expands the scope for long-term investment and contributes to its growth. The integration of digital solutions into logistics and transport infrastructure accelerates the country's involvement in key international initiatives, offering new opportunities for global trade and reinforcing its strategic position. Digitalisation helps remove existing barriers, improves coordination among transport process participants, and speeds up the transit of goods across the national territory. The Belt and Road Initiative represents a global infrastructure strategy aimed at developing trade routes connecting China with countries across Asia, Europe, and Africa. Situated at the crossroads of major trade corridors, Kazakhstan occupies a strategically important role in the implementation of this initiative. The digitalisation of logistics processes and the integration of

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technologies such as freight terminal automation, real-time cargo tracking, and management systems facilitate the faster movement of goods along these routes. One example is the "Digital Kazakhstan" project, which introduced electronic documentation and monitoring systems, resulting in a 30% reduction in cargo processing times at border checkpoints and a 25% acceleration in customs clearance procedures. Through digital solutions, the country is becoming a more attractive and reliable partner for international trade, thereby strengthening its global position. For instance, the modernisation of logistics infrastructure at key nodes such as the port of Aktau led to a 40 per cent increase in container handling capacity, improving foreign trade and reinforcing ties with international partners (World Bank, 2020).

The Trans-Caspian International Transport Route, which links China, Central Asia, the Caucasus, and Europe, also benefits from the adoption of digital technologies. The digitalisation of routes and cargo flow management systems reduces transportation time, lowers costs, and enhances delivery accuracy. For instance, the integration of real-time cargo tracking systems along the Trans-Caspian route improved coordination and reduced errors by 15%. This development is particularly important for the growth of the Trans-Caspian corridor, which competes with other international routes, such as the maritime path via the Suez Canal. The implementation of technologies, including IoT, automated transport control systems, and blockchain for transparency and security contributes to process optimisation and increases the efficiency of cargo movement across the national territory. In particular, the application of blockchain technologies within the Customs Union accelerated declaration procedures and improved cargo security, making the Trans-Caspian route more competitive and reducing transactional risks. Digital solutions considerably enhance coordination among countries and stakeholders involved in international transport initiatives. The use of a unified digital platform for data exchange between public authorities, logistics providers, and other participants expedites customs procedures, minimises the risk of errors, and improves overall process transparency. This is especially important in the context of global initiatives, where the rapid and efficient movement of goods across multiple borders is essential for successful project implementation. A notable element of digitalisation is the establishment of "smart" transport hubs and logistics centres capable of efficiently handling large volumes of cargo. These hubs are equipped with advanced information systems that enable real-time tracking, effective flow management, and timely responses to changing conditions. Due to its geographical position and active digital technology deployment, the country is positioned to become a key logistics hub between East and West, thereby increasing its role in international trade (Parola *et al.*, 2021).

The digital transformation of the transport and logistics sector creates new opportunities for efficient supply chain and transaction management on a global scale. TradeLens, a digital platform developed by a consortium led by Maersk and IBM, provides end-to-end cargo tracking and management capabilities. Through blockchain technology, the platform ensures full transparency of supply chain operations, from origin to final destination. Every action within the supply chain is recorded on the blockchain, rendering the process fully traceable and resistant to interference. Participation in such global ecosystems enables companies within the country to integrate more effectively into international trade, improve coordination with partners, and reduce the risk of errors typically associated with conventional supply chain management. Enhanced transparency also increases trust among supply chain participants, thereby lowering transactional risks such as fraud or delivery delays.

Alibaba Logistics, as part of the broader ecosystem-based approach of the Alibaba Group, represents a comprehensive platform for managing international logistics. This system integrates all aspects of logistics, including transportation, warehousing, documentation, and payments. The use of digital tools within this platform enhances supply chain control, facilitates cost management, and mitigates risks associated with international trade processes. Participation in such international ecosystems grants the country access to global supply networks and enables the adoption of advanced digital solutions to accelerate delivery processes and improve competitiveness. Integration into international digital platforms offers advantages for actors involved in transport and logistics operations. These include improved coordination and synchronisation of processes, reduced processing times, and lower operational costs. Such platforms provide real-time tracking of goods and deliver information on location and shipment status, allowing for the early identification and resolution of potential issues. This reduces risks linked to delays or product damage and increases overall customer satisfaction. Participation in international ecosystems also creates opportunities for small and medium-sized enterprises. Digital platforms enable businesses to enter global markets and establish partnerships with international stakeholders without the need for substantial infrastructure investment. These platforms reduce entry barriers to international trade and simplify engagement with logistics operators, regulatory authorities, and other participants in the supply chain (Falcone *et al.*, 2021).

Rapid adoption of innovative technologies in the logistics sector is improving the efficiency of transport processes (Sapiński & Pochopień, 2023). One of the most promising areas of development is the emergence of "smart" logistics hubs equipped with advanced technologies such as IoT, AI, and Big Data. The implementation of these technologies in logistics centres in Almaty and Astana led to substantial improvements in freight flow management, shorter processing times, and increased overall efficiency within the national transport system (Table 2).

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Table 2. Implementation of IoT, AI, and Big Data technologies in logistics hubs

Category	Indicators/actions	Projected outcomes
IoT technologies	Deployment of sensors and smart devices for monitoring and control	Improved real-time tracking capabilities
Use of AI	Process automation and forecasting of transport service demand	Enhanced forecasting accuracy and operational optimisation
Application of Big Data	Analysis of transport flows and consumer trends	Route optimisation and reduced logistics costs
Freight efficiency	Reduction in processing and delivery times	Faster transport processes and lower operational expenses

Source: compiled by the authors based on A.C. Ikegwu *et al.* (2022), A.O. Ajayi & H. Kumkale (2023), L.A. Gómez *et al.* (2024)

IoT comprises a network of physical objects equipped with sensors, software, and other technologies for data exchange. Within a logistics context, IoT facilitates real-time monitoring of cargo location and condition, enhancing supply chain management and reducing risks associated with losses or delays (Gomez *et al.*, 2024). Implementation of such systems in logistics hubs located in Almaty and Astana enables the integration of all operations into a unified digital platform, increasing the accuracy and transparency of freight processing. This approach contributes to greater flexibility in logistics, more responsive adaptation to supply chain changes, and improved communication among transport process stakeholders.

Intelligent systems powered by AI play a critical role in optimising routing, planning, and forecasting processes. AI analyses large volumes of data related to freight transport, weather conditions, road congestion, and other variables to propose optimal delivery routes. This results in shorter transit times and reduced fuel and resource expenditure. In logistics hubs in Almaty and Astana, AI facilitates faster freight handling and enables automation of numerous processes, enhancing operational efficiency and decreasing reliance on manual intervention. Predictive capabilities of AI also support early identification of potential issues, such as delays or cargo damage, and provide solutions for their mitigation (Ajayi & Kumkale, 2023).

Big Data contributes to more informed and strategic decision-making by processing vast datasets from multiple sources (Ikegwu *et al.*, 2022). In logistics hubs in Almaty and Astana, the application of Big Data allows for comprehensive analysis of transport operations, identification of bottlenecks, and implementation of corrective measures. Data-driven insights support the forecasting of transport demand, inventory optimisation, and overall improvement in logistics centre performance. Moreover, the use of Big Data enhances customer service quality by offering up-to-date information regarding the location and status of shipments.

The development of "smart" logistics hubs in Almaty and Astana contributes to the integration of Kazakhstan into global logistics chains, enhancing its competitiveness and attractiveness for international partners. These technologies improve freight transport efficiency, support more effective management of transport flows, and reduce operational costs. Through active implementation of innovative technologies, Kazakhstan is positioned to enhance the quality and speed of goods delivery both domestically and internationally, thereby strengthening its standing on the global stage (Baktymbet *et al.*, 2024). Digital transformation of the logistics sector in Kazakhstan may contribute to GDP growth of 2-3% and an increase in export volumes by 5-7%, owing to improved efficiency and cost reduction (Kredina *et al.*, 2022). A SWOT analysis is used to examine the challenges associated with this digital transition (Table 3).

Table 3. SWOT analysis of the digitalisation of the logistics sector in Kazakhstan

Strengths	Weaknesses	Opportunities	Threats
Potential GDP growth of 2-3%	Low levels of digital literacy among employees	Adoption of AI, Big Data, and IoT technologies to enhance efficiency	Cybersecurity risks and data protection concerns during the digital transition
Improved efficiency of logistics operations, resulting in cost reduction	Inadequate infrastructure for digital technology deployment in remote areas	Attraction of international investment into digital projects	Limited readiness of some businesses and public authorities for the adoption of new technologies
Enhanced international competitiveness due to improved logistics	Restricted investment in digital development by small and medium-sized enterprises	Creation of new employment opportunities in the IT and digital technology sectors	Difficulties in adapting outdated processes and technologies to modern digital systems
Reduction in transaction time and costs through process automation	Demand for skilled personnel capable of working with advanced technologies	Opportunity to improve cooperation with neighbouring countries in the context of international trade	Potential risks for conventional economic sectors if digital transformation is implemented ineffectively

Source: compiled by the authors based on World Bank (2024)

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Digital transformation within the logistics sector in Kazakhstan holds significant potential for improving efficiency and supporting economic growth. Introduction of advanced technologies can lead to substantial cost reductions, enhanced logistics operations, faster delivery times, and improved global competitiveness. However, several challenges remain. These include low levels of digital literacy among workers, insufficient infrastructure in remote areas, and limited investment in digitalisation among small and medium-sized enterprises, all of which hinder the pace of technological advancement. Nonetheless, opportunities such as the deployment of AI and Big Data, the creation of new employment in the IT sector, and the potential for stronger international trade relations offer a positive outlook for future development. Therewith, threats relating to cybersecurity, difficulty in adapting legacy systems, and partial readiness among businesses and governmental institutions may impede progress. One of the most notable challenges is the limited availability of digital infrastructure. In the context of rapid technological advancement, logistics companies often face a shortage of modern IT solutions and equipment necessary for effective operations. Network technologies, automation systems, and data integration tools require further development to ensure continuous and efficient real-time information processing. Moreover, many regions in Kazakhstan still lack sufficient access to the Internet and digital platforms, which slows digital transformation and diminishes its overall impact.

Another major barrier involves the low level of digital literacy among personnel. At present, a significant proportion of employees within logistics companies and public institutions lack the necessary knowledge and skills required to operate new digital tools effectively (Krzywdzinski *et al.*, 2022). The implementation of advanced technologies such as AI, Big Data, and IoT demands a highly qualified workforce capable of applying these tools efficiently. Without proper training and education, the pace of digital transformation will remain slow, and even the most promising technological solutions will not be fully utilised. This creates a pressing need for both public and private sectors to invest in educational initiatives and skills development programmes. Several initiatives have already been launched or are under development to address this challenge, including the introduction of specialised digital skills courses for employees at all levels, reskilling and upskilling programmes for logistics professionals and public sector staff. Online learning platforms are also actively developing, allowing employees to learn new digital technologies at a convenient time. Furthermore, partnerships between government institutions and the private sector are increasingly important for the design of innovative educational programmes focused on skills development in areas such as AI, Big Data analytics, and IoT integration. Cybersecurity has also become an increasingly pressing issue with the expansion of digital platforms and automated systems. The integration of new technologies into logistics operations involves the connection of multiple stakeholders through digital platforms,

which raises the risk of data breaches, cyberattacks, and other security threats. Within the context of globalisation and integration into international logistics networks, the protection of information and transaction security has become critically important. Developing infrastructure capable of ensuring cybersecurity requires substantial investment in secure systems and software solutions.

Financial barriers also present a significant challenge to the implementation of digital technologies. High initial investment costs associated with digital infrastructure, equipment, training, and the recruitment of qualified professionals may prove prohibitive for many businesses, particularly small and medium-sized enterprises. In such cases, state support and subsidies play an essential role, although economic instability may still hinder companies from pursuing large-scale digital projects even in the presence of financial assistance. A comprehensive approach is required to overcome these challenges. This should involve the development of digital infrastructure, the establishment of targeted educational programmes to improve workforce qualifications, the enhancement of cybersecurity measures, and financial support mechanisms provided by the government. Public programmes and private initiatives must be strategically aligned to remove existing barriers, enabling rapid and effective digital transformation. This would ensure the sustainable development of the logistics sector and strengthen the position of Kazakhstan within the global economy. Kazakhstan occupies a strategically important geographical position, enabling it to play a key role in international transport and logistics flows by linking Europe and Asia (Jablonskis *et al.*, 2018). In recent years, the country has actively pursued efforts to strengthen its position as a major regional hub, and the integration of digital technologies presents significant opportunities in this regard. With the successful adoption of such technologies in the transport and logistics sector, Kazakhstan has the potential to emerge as the leading logistics centre in Central Asia, offering competitive advantages compared to other countries in the region.

The digitalisation of logistics infrastructure can improve the efficiency of freight transportation and streamline operational processes, both of which are essential for the development of a successful logistics hub. The introduction of technologies such as IoT, AI, blockchain, and Big Data will open up new opportunities for Kazakhstan in supply chain management, real-time cargo monitoring, and increased transparency of operations. All of these developments will render transport routes more efficient, reduce costs, and increase the speed of goods delivery, which constitutes a crucial factor for attracting international logistics operators. By becoming a regional hub, Kazakhstan may not only strengthen the internal economy but also become an important link in the global logistics chain, providing its partners from Europe, Asia, and the Middle East with fast and secure routes for goods transportation. The advantages of Kazakhstan as a regional hub are also found in the transport infrastructure,

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which is actively developing, and in the support provided by the state, which is focused on improving the business climate and creating favourable conditions for investors. Key factors for success in this area include investment in the modernisation of transport infrastructure, development of intelligent logistics platforms, and improvement of personnel qualifications required to work with new digital technologies. Kazakhstan has all the necessary potential for the implementation of these tasks: strategic location, developing infrastructure, and support for digitalisation initiatives at both state and private levels.

Effective digital transformation in the logistics sector of Kazakhstan requires a focus on the development of digital infrastructure, in particular, the modernisation of existing platforms and the adoption of the latest technologies, including IoT, AI, and blockchain. Optimisation of digital transformation must include modernisation and unification of digital platforms through the development of common data exchange standards between different logistics systems, creation of a national digital logistics ecosystem integrated with international platforms (TradeLens, Alibaba Logistics), and adoption of blockchain solutions for automation and transparency of document circulation. It is also important to use advanced technologies to improve efficiency, including the deployment of IoT devices for real-time cargo monitoring, the introduction of AI algorithms for forecasting demand for transport services and route optimisation, and the development of automated customs systems allowing faster processing of transit goods. Another key area is training of personnel and development of digital competencies, which requires creation of educational programmes in digital logistics at universities and specialised centres, organisation of advanced training courses for employees of logistics companies and government bodies, and implementation of internship programmes and partnerships with international technology and logistics companies. Implementation of these initiatives requires investment and development of international cooperation, including the design of state programmes supporting digital logistics with subsidisation of key projects, attraction of foreign investors through creation of favourable conditions for implementation of innovative solutions, and active participation in international logistics alliances and development of public-private partnerships in logistics digitalisation. Implementation of these measures will allow Kazakhstan to reduce transactional costs, increase transparency in supply chains, and accelerate movement of goods across borders, ensuring the country remains competitive in the global transport system.

Discussion

The findings of the study confirm that digital technologies played a substantial role in enhancing the efficiency and competitiveness of the transport and logistics sector. The adoption of innovative solutions such as automation, IoT, and AI contributed to faster data processing and improved

coordination of logistics processes. The integration of these technologies not only increased the sector's productivity but also created favourable conditions for its continued development in line with global trends. This issue was also explored by M. Yang *et al.* (2021), who demonstrated that digital technologies substantially improve efficiency within the logistics industry by optimising transport and warehouse management processes. The implementation of GPS systems, IoT, and data analytics enhances real-time tracking and management of goods, minimising delays and reducing operational costs. These improvements contribute not only to cost savings but also to service quality enhancement, thereby making firms more competitive in the market. K. Lee *et al.* (2023) similarly demonstrated that the transport sector benefits from the integration of automated solutions and AI for demand forecasting and route optimisation. These technologies facilitate a reduction in carbon emissions, which is essential in light of increasingly stringent environmental standards. The use of digital platforms for interaction with clients and partners expands opportunities for cooperation and supports the development of more flexible and adaptive business models.

The implementation of digital technologies requires substantial investment in infrastructure and workforce training, which can present a barrier for small and medium-sized enterprises. However, such investments are justifiable for larger organisations, as they enhance profitability and reduce operational risks. With technological advancement, it is becoming possible to develop more flexible and scalable solutions that are accessible to a broader range of companies, thereby supporting the overall growth of the sector. Analysis of the impact of digital solutions on the reduction of transactional costs indicates that the use of electronic documentation simplifies administrative procedures and minimises bureaucratic barriers. This accelerates operational processes, improves transparency in logistics activities, and reduces the costs associated with document handling. Consequently, the digitalisation of administrative procedures has become a vital instrument for the optimisation of transport flows. D. Baviskar *et al.* (2021) concluded that the automation of document management in logistics reduces administrative obstacles by decreasing reliance on manual processing of paper documents and minimising the frequency of errors. Electronic data exchange systems and integration with other information platforms accelerate approval and coordination procedures, thereby reducing waiting times and increasing responsiveness. This is particularly important in international trade, where delays can disrupt supply chains and result in financial losses.

The study conducted by H. Gupta *et al.* (2022) identified the reduction of transactional costs as another important outcome of automating document management. Systems based on blockchain technology, electronic signatures, and other modern tools enhance transparency and security in transactions, thereby lowering the costs associated with auditing and verification. Furthermore,

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automation reduces the workload of personnel by relieving them of routine tasks, allowing their expertise to be redirected toward more complex and professional operations. These findings support the research discussed earlier, as the implementation of automated systems indeed leads to a notable reduction in the time required for document processing and in the number of errors caused by human factors. The use of such technologies enables much faster data exchange among participants in the logistics chain and simplifies document verification and approval. As a result, automation creates a more transparent and efficient environment for information management, which improves overall productivity and reduces operational risks (Zavadska & Oksenyuk, 2023). The study also demonstrated that digital transformation encourages investment in logistics infrastructure. Enhancements to the digital ecosystem and process automation attracted the attention of private and public investors, opening up new opportunities for financing logistics modernisation (Artyukh *et al.*, 2023). Continued sectoral growth, however, requires ongoing efforts to build a favourable investment climate, including the development of regulatory frameworks and the expansion of governmental support.

Notably, the paper by H. Zhou *et al.* (2023) also highlighted that the sources and mechanisms of financing digitalisation in logistics involve both private and public investments aimed at upgrading infrastructure and implementing new technologies. Private enterprises are increasingly viewing investment in digitalisation as a long-term strategy for improving competitiveness, which draws interest from venture capital and private equity funds. Government initiatives, such as subsidies and tax incentives, continue to play a vital role in advancing digital transformation, particularly in cases where infrastructure projects demand substantial upfront capital. C. Wang *et al.* (2021), in turn, concluded that attracting investment in the development of logistics infrastructure requires the formulation of a clear strategy that demonstrates the potential and return on investment in digital technologies. Investors seek projects that promise substantial improvements in operational efficiency and the development of new business models. Public-private partnerships serve as an essential mechanism in this context, offering access to additional capital sources and distributing risk in a way that fosters favourable conditions for long-term investment in the modernisation of logistics systems. These findings are consistent with the arguments presented in the preceding section, as they confirm the importance of both private and public sources of funding in supporting the successful digitalisation of the logistics sector. The attraction of venture capital and private investment contributes to the implementation of innovative solutions capable of enhancing the competitiveness of enterprises. Therewith, government support through subsidies and tax incentives creates additional drivers for infrastructure development and the adoption of advanced technologies, thereby improving overall efficiency in the logistics sector.

The development of international transport corridors turned out to be inextricably linked with the introduction of digital solutions (Trushaj, 2023). Integration into global supply chains helped strengthen the country's role in international trade. Automated cargo monitoring and management systems reduced transit time and improved coordination with international partners, which increased the attractiveness of the country as a transit hub (Akhmet *et al.*, 2025). E. Tijan *et al.* (2021) also confirmed that digital solutions play a key role in accelerating the international integration of the transport sector, ensuring seamless communication between different participants in the supply chain. Modern technologies, including blockchain, supply chain management systems, and the automation of customs procedures, considerably streamline operations, increasing transparency and transaction speed. These developments allow for the creation of more efficient and predictable international freight routes, reducing delivery times and minimising operational risks. R. Palu & O.-P. Hilmola (2023) similarly found that the prospects for developing global logistics corridors are closely tied to the adoption of digital technologies that enable the integration of diverse transport networks and improve coordination among countries. In particular, digitalisation supports the effective management of large volumes of data and the analysis of demand trends, facilitating improved forecasting and route optimisation. Looking ahead, further advances in AI and IoT are expected to lead to the emergence of more adaptive and resilient global logistics corridors, capable of responding swiftly to shifts in market conditions and international policy.

A comparison of the study findings indicates that digitalisation does indeed accelerate the integration of international transport systems and improves coordination across regions. The adoption of technologies such as blockchain and IoT not only enhances transparency but also reduces the costs associated with information management and processing (Rama *et al.*, 2023). This leads to improved operational efficiency and a reduction in the time required for customs procedures, thereby accelerating the movement of goods through global logistics corridors. Integration into global digital platforms shows a positive impact on supply chain transparency and risk reduction. The use of such ecosystems minimised errors in cargo handling and increased trust among international partners (Matsiuk *et al.*, 2023). The implementation of intelligent logistics hubs also played a crucial role in enhancing the efficiency of transport operations, underscoring the need for further expansion of these solutions. Y. Issaoui *et al.* (2022) concluded that digital platforms are essential for supply chain optimisation, providing real-time tracking and control over cargo at every stage of the supply chain. These platforms enable synchronisation among all participants, from suppliers and carriers to end customers, improving coordination and reducing the likelihood of delays. Their implementation promotes

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process automation, shortens order processing times, and enhances planning accuracy. T. Morgan *et al.* (2023) uncovered that the transparency offered by digital platforms lowers logistical risks by enabling the early identification of problems and the implementation of corrective measures. Monitoring and analytics systems help detect bottlenecks and predict potential disruptions, facilitating timely responses to changes. This reduces uncertainty and risk in the delivery of goods and strengthens trust among supply chain stakeholders.

The findings indicate that the use of digital platforms considerably improves coordination within supply chains, enhancing overall operational efficiency and precision. These solutions optimise planning and tracking processes and enable swift responses to change, which is an essential factor in maintaining uninterrupted supply flows. This confirms that digitalisation is a critical component of strategies aimed at boosting competitiveness and reducing risks within the logistics sector. Despite the positive outcomes, the study identified several challenges hindering the digital transformation of the logistics sector. Insufficient digital infrastructure, a shortage of qualified specialists, cybersecurity risks, and financial barriers slow the adoption of new technologies. Addressing these challenges effectively requires a comprehensive approach involving government support, educational initiatives, and improvements to the regulatory framework. Overall, the study demonstrated that through the active adoption of digital technologies, the country could strengthen its position as a regional logistics hub and enhance its competitiveness in the global market.

Conclusions

The study indicated that the introduction of digital technologies enhances the efficiency of the transport and logistics sector in the country. Process automation and the utilisation of AI, IoT, and Big Data led to notable improvements in sector productivity. The implementation of these technologies accelerated data processing, improved the coordination of logistics operations, and enabled the optimisation of delivery routes. These developments contributed to a reduction in logistics costs, which in turn supported the growth of competitiveness across individual enterprises and the industry as a whole. Particular attention was devoted to the adoption of electronic documentation, including the e-CMR and the "Astana-1" system. These technological solutions substantially reduced transaction costs by lowering bureaucratic barriers and streamlining administrative procedures. As a result, the number of errors decreased, the processing of transport documents was accelerated, and the transparency of operations improved. Electronic documentation also facilitated enhanced conditions for tracking and controlling shipments, thereby strengthening trust and increasing operational efficiency both domestically and in collaboration with international partners.

The digitalisation of transport logistics also contributed to a rise in investment directed towards the modernisation of logistics infrastructure. The allocation of resources towards new technologies and the development of innovative platforms created favourable conditions for attracting investors. Forecasted investment volumes in digital infrastructure range between 500 and 800 million USD, with an anticipated return on investment of 15-20% over a period of three to five years. This supported growth in the construction of modern logistics hubs, infrastructure enhancement, and the development of new transport corridors. Estimated volumes for international investment projects are valued at 600 to 900 million USD, with projected returns of 18-25%, while public-private partnerships are expected to attract between 400 and 600 million USD, with returns of 12-18% over two to four years.

The study further demonstrated that the country succeeded in strengthening its position in international logistics through active integration into global transport initiatives such as the Belt and Road Initiative and the Trans-Caspian International Transport Route. Digital solutions, including automated cargo monitoring and management systems, accelerated integration into these initiatives, resulting in improved transit quality and speed, and enhanced coordination with participating countries. The study identified several challenges hindering the successful digital transformation of the transport and logistics sector, including insufficient digital infrastructure, low levels of digital literacy, and cybersecurity concerns. These barriers require a comprehensive approach involving the development of infrastructure and the implementation of educational programmes aimed at improving workforce qualifications. It is also essential to develop strategies for ensuring data security, which would enhance trust among international partners and accelerate the development of cross-border cooperation.

Thus, despite the existing challenges, digital transformation within the transport and logistics sector in the country demonstrates considerable potential for enhancing competitiveness and resilience on the international stage. With the continued adoption of innovative technologies and the removal of structural barriers, the country has the opportunity to become a key logistics hub in Central Asia, attracting international investment and generating new business opportunities. A more in-depth understanding of the long-term implications of digital technology adoption is required to evaluate its impact on the sustainability of the ecosystem and its effects on small and medium-sized enterprises.

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References

[1] Ajayi, A.O., & Kumkale, H. (2023). *Optimising urban road transportation efficiency: AI-driven solutions for reducing traffic congestion in big cities*. doi: 10.13140/RG.2.2.16130.45763.

[2] Akhmet, A., Nurekenova, E., Rakhimberdinova, M., Nurmukhametov, N., & Vasa, L. (2025). The impact of transport routes on Kazakhstan's agro-industrial complex considering ESG approaches. *Problems and Perspectives in Management*, 23(1), 656-672. doi: 10.21511/ppm.23(1).2025.49.

[3] An, H., Razzaq, A., Nawaz, A., Noman, S.M., & Khan, S.A. (2021). Nexus between green logistic operations and triple bottom line: Evidence from infrastructure-led Chinese outward foreign direct investment in Belt and Road host countries. *Environmental Science and Pollution Research*, 28(37), 51022-51045. doi: 10.1007/s11356-021-12470-3.

[4] Artyukh, T., Ternova, A., & Hryhorenko, I. (2023). The state of the world market of logistics services and the main trends in its development. *Commodity Bulletin*, 16(1), 116-128. doi: 10.36910/6775-2310-5283-2023-17-10.

[5] Attah, R.U., Garba, B.M., Gil-Ozoudeh, I., & Iwuanyanwu, O. (2024). Strategic frameworks for digital transformation across logistics and energy sectors: Bridging technology with business strategy. *Open Access Research Journal of Science and Technology*, 12(2), 70-80. doi: 10.53022/oarjst.2024.12.2.0142.

[6] Baktymbet, A.S., Baktymbet, S.S., Idrisov, M.M., & Serikkyzy, A. (2024). Industrial and innovative development: Challenges and prospects for Kazakhstan. *Vestnik KazUTB*, 3(24), 531-539. doi: 10.58805/kazutb.v.3.24-568.

[7] Baviskar, D., Ahirrao, S., Potdar, V., & Kotecha, K. (2021). Efficient automated processing of the unstructured documents using artificial intelligence: A systematic literature review and future directions. *IEEE Access*, 9, 72894-72936. doi: 10.1109/ACCESS.2021.3072900.

[8] Chang, C.H., Lu, C.S., & Lai, P.L. (2022). Examining the drivers of competitive advantage of the international logistics industry. *International Journal of Logistics Research and Applications*, 25(12), 1523-1541. doi: 10.1080/13675567.2021.1915263.

[9] Chen, C.L., Lin, Y.C., Chen, W.H., Chao, C.F., & Pandia, H. (2021). Role of government to enhance digital transformation in small service business. *Sustainability*, 13(3), article number 1028. doi: 10.3390/su13031028.

[10] Ding, Y., Jin, M., Li, S., & Feng, D. (2021). Smart logistics based on the internet of things technology: An overview. *International Journal of Logistics Research and Applications*, 24(4), 323-345. doi: 10.1080/13675567.2020.1757053.

[11] Falcone, E., Kent, J., & Fugate, B. (2021). Supply chain technologies, interorganizational network and firm performance: A case study of Alibaba Group and Cainiao. *International Journal of Physical Distribution & Logistics Management*. doi.org/10.1108/IJPDLM-08-2018-0306.

[12] Gómez, L.A., Rodríguez, M., Herrera, J.M., Flores, A., Vander Peterson, C., & Martínez, G. (2024). *Design of an integrated collaborative intelligence framework for real-time identification of vulnerabilities in international logistics networks*. Retrieved from https://www.researchgate.net/publication/387949120_Design_of_an_Integrated_Collaborative_Intelligence_Framework_for_Real-Time_Identification_of_Vulnerabilities_in_International_Logistics_Networks.

[13] Gupta, A., Singh, R.K., & Gupta, S. (2022). Developing human resource for the digitization of logistics operations: Readiness index framework. *International Journal of Manpower*, 43(2), 355-379. doi: 10.1108/IJM-03-2021-0175.

[14] Gupta, H., Yadav, A.K., Kusi-Sarpong, S., Khan, S.A., & Sharma, S.C. (2022). Strategies to overcome barriers to innovative digitalisation technologies for supply chain logistics resilience during pandemic. *Technology in Society*, 69, article number 101970. doi: 10.1016/j.techsoc.2022.101970.

[15] Ikegwu, A.C., Nweke, H.F., Anikwe, C.V., Alo, U.R., & Okonkwo, O.R. (2022). Big data analytics for data-driven industry: A review of data sources, tools, challenges, solutions, and research directions. *Cluster Computing*, 25(5), 3343-3387. doi: 10.1007/s10586-022-03568-5.

[16] International Road and Transport Union. (n.d.). *Making freight truly paperless: e-CMR*. Retrieved from https://www.iru.org/what-we-do/facilitating-trade-and-transit/e-cmr.

[17] Issaoui, Y., Khiat, A., Haricha, K., Bahnasse, A., & Ouajji, H. (2022). An advanced system to enhance and optimize delivery operations in a smart logistics environment. *IEEE Access*, 10, 6175-6193. doi: 10.1109/ACCESS.2022.3141311.

[18] It is now possible to pay for public transport in Astana with a bank card. (2024). Retrieved from https://www.gov.kz/memleket/entities/astana/press/news/details/703694?lang=ru.

[19] Jablonskis, A., Petersone, M., & Ketners, K. (2018). Insights into the definition of customs logistics. *Intellectual Economics*, 12(1), 16-33. doi: 10.13165/IE-18-12-1-02.

[20] Kazbekov, B., Akhmetova, Z., & Elesheva, J. (2024). Improving the efficiency of cargo transportation management based on the implementation of information technologies. *KazATC Bulletin*, 134(5), 115-123. doi: 10.52167/1609-1817-2024-134-5-115-123.

[21] Kredina, A., Akhtanova, M., Bekturganova, M., Tsoy, A., & Spankulova, L. (2022). The relationship between logistics and information and communication technologies and their impact on the economy of Kazakhstan. *Problems and Perspectives in Management*, 20(4), 344-355. doi: 10.21511/ppm.20(4).2022.26.

[22] Krzywdzinski, M., Pfeiffer, S., Evers, M., & Gerber, C. (2022). *Measuring work and workers: Wearables and digital assistance systems in manufacturing and logistics*. Retrieved from https://www.econstor.eu/handle/10419/251912.

Scientific Bulletin of Mukachevo State University. Series "Economics", 12(2)

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[23] Lee, K.L., Wong, S.Y., Alzoubi, H.M., Al Kurdi, B., Alshurideh, M.T., & El Khatib, M. (2023). Adopting smart supply chain and smart technologies to improve operational performance in manufacturing industry. *International Journal of Engineering Business Management*, 2023, article number 15. doi: 10.1177/18479790231200614.

[24] Matsiuk, V., Opalko, V., Savchenko, L., Zagurskiy, O., & Matsiuk, N. (2023). Optimisation of transport and technological system parameters of an agricultural enterprise in conditions of partial uncertainty. *Machinery & Energetics*, 14(3), 61-71. doi: 10.31548/machinery/3.2023.61.

[25] Mikl, J., Herold, D.M., Ćwiklicki, M., & Kummer, S. (2021). The impact of digital logistics start-ups on incumbent firms: A business model perspective. *The International Journal of Logistics Management*, 32(4), 1461-1480. doi: 10.1108/IJLM-04-2020-0155.

[26] Morgan, T.R., Gabler, C.B., & Manhart, P.S. (2023). Supply chain transparency: Theoretical perspectives for future research. *The International Journal of Logistics Management*, 34(5), 1422-1445. doi: 10.1108/IJLM-02-2021-0115.

[27] Njoku, J.N., Nwakanma, C.I., Amaizu, G.C., & Kim, D.S. (2023). Prospects and challenges of Metaverse application in data-driven intelligent transportation systems. *IET Intelligent Transport Systems*, 17(1), 1-21. doi: 10.1049/itr2.12252.

[28] Odimarha, A.C., Ayodeji, S.A., & Abaku, E.A. (2024). Securing the digital supply chain: Cybersecurity best practices for logistics and shipping companies. *World Journal of Advanced Science and Technology*, 5(1), 26-30. doi: 10.53346/wjast.2024.5.1.0030.

[29] Palu, R., & Hilmola, O.-P. (2023). Future potential of trans-Caspian corridor. *Logistics*, 7(3), article number 39. doi: 10.3390/logistics7030039.

[30] Panjee, P., Kaewchueaknang, V., & Amornsawadwatana, S. (2025). A systematic literature review of cargo loss risks in road transportation: Impacts and future directions. *Safety*, 11(1), article number 20. doi: 10.3390/safety11010020.

[31] Parola, F., Satta, G., Buratti, N., & Vitellaro, F. (2021). Digital technologies and business opportunities for logistics centres in maritime supply chains. *Maritime Policy & Management*, 48(4), 461-477. doi: 10.1080/03088839.2020.1802784.

[32] Ping, G., Zhu, M., Ling, Z., & Niu, K. (2024). Research on optimizing logistics transportation routes using AI large models. *Spectrum of Research*, 4(1).

[33] Plesner, U., & Justesen, L. (2022). The double darkness of digitalization: Shaping digital-ready legislation to reshape the conditions for public-sector digitalization. *Science, Technology, & Human Values*, 47(1), 146-173. doi: 10.1177/0162243921999715.

[34] Polukhina, E., & Mizanbekova, S. (2022). Analysis of the transport and logistics complex of the Republic of Kazakhstan. *Eastern-European Journal of Enterprise Technologies*, 5(13), 21-31. doi: 10.15587/1729-4061.2022.265232.

[35] Rama, H.H., Rama, V.H., & Rexhepi, B.R. (2023). The impact of marketing and technological factors on the quality, safety and sales of wine. *Quality – Access to Success*, 24(196), 49-53. doi: 10.47750/QAS/24.196.06.

[36] Sapiński, A., & Pochopień, J. (2023). Logistics innovations and their impact on the development of transportation infrastructure in Europe: Future prospects. *Futurity of Social Sciences*, 1(2), 4-17. doi: 10.57125/FS.2023.06.20.01.

[37] Tan, W.K., & Sundarakani, B. (2021). Assessing Blockchain Technology application for freight booking business: A case study from Technology Acceptance Model perspective. *Journal of Global Operations and Strategic Sourcing*, 14(1), 202-223. doi: 10.1108/JGOSS-04-2020-0018.

[38] Tijan, E., Jović, M., Aksentijević, S., & Pucihar, A. (2021). Digital transformation in the maritime transport sector. *Technological Forecasting and Social Change*, 170, article number 120879. doi: 10.1016/j.techfore.2021.120879.

[39] TradeLens digital platform: Dynamics of change for the container business. (2020). Retrieved from https://usm.media/czifrovaya-platforma-tradelens-dinamika-izmenenij-dlya-kontejnernogo-biznesa/.

[40] Trushaj, A. (2023). Features of the foreign policy of the Republic of Kazakhstan. *Foreign Affairs*, 33(5), 45-51. doi: 10.46493/2663-2675.33(5).2023.45-51.

[41] Wang, C., Kim, Y.-S., & Kim, C.Y. (2021). Causality between logistics infrastructure and economic development in China. *Transport Policy*, 100, 49-58. doi: 10.1016/j.tranpol.2020.10.005.

[42] World Bank. (2020). *South Caucasus and Central Asia: The Belt and Road initiative Kazakhstan country case study*. Retrieved from https://surl.lu/nsogqz.

[43] World Bank. (2024). *Challenges and Changes: Kazakhstan Through Eyes of World Bank*. Retrieved from https://www.worldbank.org/en/news/opinion/2024/03/27/challenges-and-changes-kazakhstan-through-eyes-of-world-bank.

[44] Yang, M., Fu, M., & Zhang, Z. (2021). The adoption of digital technologies in supply chains: Drivers, process and impact. *Technological Forecasting and Social Change*, 169, article number 120795. doi: 10.1016/j.techfore.2021.120795.

[45] Yesenzholova, G.D., & Dulambaeva, R.T. (2024). *Customs regulation of foreign trade of the Republic of Kazakhstan*. Astana: Academy of Public Administration under President of the Republic of Kazakhstan.

[46] Zavadska, O., & Oksenyuk, K. (2023). Present information technologies in transport and warehouse logistics. *Economic Forum*, 13(4), 142-147. doi: 10.36910/6775-2308-8559-2023-4-18.

[47] Zhou, H., Wang, Q., Wang, L., Zhao, X., & Feng, G. (2023). Digitalization and third-party logistics performance: Exploring the roles of customer collaboration and government support. *International Journal of Physical Distribution & Logistics Management*, 53(4), 467-488. doi: 10.1108/IJPDLM-12-2021-0532.

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Цифрова трансформація в транспортно-логістичному секторі Казахстану: Виклики та можливості для глобальної інтеграції

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Анотація. Мета дослідження полягала у визначенні ключових переваг та викликів цифровізації в транспортно-логістичному секторі Казахстану та оцінці її впливу на економічне зростання та міжнародне співробітництво. У дослідженні використовувались методи аналізу, оцінки та прогнозування для визначення впливу цифрових технологій на різні аспекти транспортно-логістичної системи Казахстану, включаючи продуктивність, інвестиційну привабливість та глобальну інтеграцію. Результати дослідження показали, що цифрова трансформація підвищує ефективність, знижує транзакційні витрати та покращує інвестиційну привабливість сектору. Впровадження цифрових платформ, автоматизація митних процедур та використання штучного інтелекту (ШІ) прискорили обробку вантажів та оптимізували операції. Аналіз показав, що цифровізація сприяє зростанню іноземних інвестицій шляхом підвищення прозорості та передбачуваності транспортних процесів. Очікується, що приватні інвестиції в інфраструктуру досягнуть 500-800 мільйонів доларів США, що принесе 15-20 % прибутковості протягом 3-5 років, тоді як державні субсидії можуть сягнути 200-300 мільйонів доларів США з прибутковістю 10-12 % протягом 1-3 років. За оцінками, міжнародні проекти генеруватимуть 600-900 мільйонів доларів США інвестицій з очікуваною прибутковістю 18-25 % протягом 4-6 років. Очікується, що державно-приватне партнерство складе 400-600 мільйонів доларів США, пропонуючи прибутковість 12-18 % протягом 2-4 років, а інвестиції у стартапи становитимуть 100-200 мільйонів доларів США з прибутковістю 25-35 % протягом 2-3 років. Розвиток цифрових рішень у міжнародних транспортних коридорах посилює роль Казахстану як логістичного центру. Однак, основні проблеми залишились, включаючи неадекватну цифрову інфраструктуру, кіберзагрози, низький рівень цифрової грамотності та фінансові обмеження, з якими стикаються малі та середні підприємства. Ефективна трансформація вимагає тісної державно-приватної співпраці та створення «розумних» логістичних центрів. Таким чином, цифровізація в транспортно-логістичному секторі має значний потенціал для позиціонування країни як провідного логістичного центру в Центральній Азії

Ключові слова: інвестиції; автоматизація; міжнародні коридори; кібербезпека; логістична інфраструктура; глобальна інтеграція

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