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E.E. Dosmuratova[1*], R.K. Niyazbekova[1], D.M. Karimov[2]

[1] M.Auezov South Kazakhstan University, 160000, Shymkent, Republic of Kazakhstan
[2] Mirzo Ulugbek National University of Uzbekistan, 100050, Tashkent, Republic of Uzbekistan
*e-mail: 639kz@mail.ru

PROBLEMS AND PROSPECTS OF THE TRANSPORT AND LOGISTIC SYSTEM OF KAZAKHSTAN UNDER CONDITIONS OF SUSTAINABLE DEVELOPMENT

Abstract

This paper examines the functioning and development of the transport and logistics system in the Republic of Kazakhstan from 2019 to 2024. The study is based on statistical data, comparative analysis with international practices, expert assessments, and cartographic visualization of major corridors. Such a multi-method approach made it possible to evaluate both quantitative indicators and qualitative transformations in the industry. The analysis demonstrates that Kazakhstan occupies a strategically advantageous position at the crossroads of Eurasian trade flows, which predetermines its role as a key transit hub. Between 2019 and 2024, transit volumes increased significantly, particularly along the China–Europe corridor, confirming the country's growing relevance in international logistics networks. At the same time, the modal distribution of freight transportation has remained relatively stable, with railway and road transport consistently dominating. Investment activity showed a sharp rise in 2023–2024, with allocations primarily directed toward modernization of railway and road infrastructure. However, the level of financing for digital solutions and ecological innovations remained modest. This imbalance creates long-term risks, as global logistics trends are increasingly shaped by green transformation and digital platforms. Pilot projects in multimodal and environmentally friendly transport were launched, but their scale is still insufficient to ensure systemic change.

The research also highlighted key structural constraints: deterioration of infrastructure, shortage of qualified specialists, underdevelopment of logistics hubs, and insufficient digitalisation. These factors reduce Kazakhstan's competitiveness compared to leading transit economies.

The novelty of this study lies in linking investment dynamics, digitalization, and ecological priorities within a single analytical framework, which allows identifying potential strategies for sustainable sectoral development. The practical significance of the findings lies in their applicability to policymaking and business strategies, including the diversification of corridors, the balanced distribution of freight modes, and the targeted promotion of digital and green logistics.

Keywords: transport and logistics system, infrastructure modernization, digitalization, green logistics, investment

Introduction

In the context of globalization, the sustainable development of transport and logistics systems has become one of the decisive factors determining the competitiveness of national economies. Kazakhstan, due to its strategic geographical position in the center of Eurasia, performs the role of a key transit country connecting the markets of Europe and Asia. The intersection of major international transport corridors such as the Belt and Road Initiative, the Trans–Caspian International Transport Route, and the North–South corridor creates unique opportunities for the further development of the logistics sector and for strengthening Kazakhstan's role in global supply chains [1].

In the period 2019–2024, Kazakhstan has implemented large-scale government programs to modernize its transport infrastructure and logistics system. Among them are Nurly Zhol, Digital Kazakhstan, and the strategic program Kazakhstan–2050. These programs facilitated the construction and reconstruction of highways, railways, multimodal logistics centers, and customs terminals. Despite these positive developments, several systemic problems persist: deterioration of infrastructure, uneven development of logistics hubs, slow pace of digitalization, and insufficient integration with neighboring countries. Environmental challenges also remain highly relevant: the growing volume of cargo transportation requires the implementation of sustainable logistics models, the reduction of greenhouse gas emissions, the transition to alternative energy, and the optimization of routes using artificial intelligence and Internet of Things technologies. In this context, the development of green logistics, multimodal solutions, and energy efficiency improvements in transport processes has become particularly significant [1].

The relevance of the study lies in the need to enhance the efficiency, sustainability, and competitiveness of Kazakhstan's logistics system under the conditions of global competition, unstable financial markets, and shifts in transport flows caused by geopolitical factors. The ability of Kazakhstan to modernize its logistics system, introduce innovative approaches, and strengthen cooperation with international partners will largely determine its future position in the Eurasian region. In addition, global experience demonstrates that countries with a developed transport and logistics system achieve higher levels of integration into world trade and sustainable economic growth. For Kazakhstan, the development of logistics is not only an economic priority but also a strategic factor of national security and regional competitiveness.

The purpose of this study is to conduct a comprehensive analysis of the state and trends in Kazakhstan's transport and logistics system development from 2019 to 2024, in the context of sustainable economic growth, and to identify practical mechanisms for its modernisation.

The objectives of the research are:

1. To systematize key logistical problems at the national and regional levels;

2. To analyze the dynamics of investments, transit flows, and transportation structures in 2019–2024;

3. To assess the current state of digital transformation of logistics processes;

4. To examine international experience in logistics modernization and evaluate the possibility of its application in Kazakhstan;

5. To develop practical recommendations for increasing the efficiency and environmental sustainability of the logistics system.

The scientific novelty of the research lies in an integrated approach to the evaluation of Kazakhstan's logistics sector, which combines infrastructural, digital, institutional, and environmental aspects. For the first time, special emphasis is placed on the integration of digitalization and green logistics within a unified strategy for sustainable transport development.

The review of the literature confirms the scientific and practical importance of the topic. N. Tityukhin highlights the importance of forming logistics hubs and points to the Western China–Western Europe corridor as a priority project [3]. G. Jamalova emphasizes the role of digitalization and automation in freight flow management [4]. Raimbekov and colleagues analyze the prospects of sustainable logistics in East Kazakhstan, stressing the use of digital platforms and IT-based models [5]. These works highlight the need for further in-depth research, whereas our study aims to develop practical solutions for the modernisation and long-term transformation of Kazakhstan's transport and logistics system. The results may be applied in the activities of government bodies, ministries, and private logistics companies in shaping development strategies.

Research materials and methods

The object of this study is the transport and logistics system of the Republic of Kazakhstan. At the same time, the subject is the processes of its modernization, digital transformation, and integration into global supply chains in the period 2019–2024.

To achieve the research objectives, a complex of general scientific and applied methods was applied, each of which provided specific analytical results:

1. Statistical analysis – used to evaluate the dynamics of freight transportation volumes, investment flows, and the modal distribution of transport in Kazakhstan during 2019–2024. The data were collected from the Committee on Statistics of the Republic of Kazakhstan, the Ministry of Industry and Infrastructure Development, and annual reports of JSC «Kazakhstan Railways». This method enabled the tracing of quantitative trends and the identification of structural changes within the industry.

2. Comparative analysis – employed to assess Kazakhstan's position in the field of logistics relative to international benchmarks, particularly China, Germany, Russia, and Turkey. This approach allowed the identification of best practices and the determination of how they can be adapted to Kazakhstan's economic and geographical conditions.

3. Economic and mathematical modelling – applied to estimate the correlation between infrastructure investments and logistics efficiency indicators, as well as their impact on GDP

growth. Predictive scenarios were constructed to assess the potential effects of modernization strategies on the transport sector's long-term performance.

4. Expert assessment method – based on the opinions of logistics specialists, economists, and representatives of the transport sector. Expert surveys and interviews were used to confirm the significance of the identified barriers, such as infrastructure wear, staff shortage, and insufficient digitalisation. This ensured the inclusion of qualitative perspectives alongside statistical data.

5. Cartographic method – used to visualise the geography and development of Kazakhstan's main transport corridors (Western Europe–Western China, Trans–Caspian International Transport Route, North–South). The cartographic approach helped to assess both geographical advantages and logistical constraints of the country's transit potential.

6. System analysis – provided an integrated framework for combining infrastructural, digital, institutional, and ecological factors affecting the logistics system. This method ensured that the research results reflect the interdependence of economic efficiency and sustainability in the transport sector.

The combination of these methods allowed for a balanced study, where expert assessments and international comparisons supplemented quantitative indicators for 2019–2024. This methodological approach strengthens the reliability of conclusions and ensures that the recommendations developed are both scientifically valid and practically applicable [7].

Results and their discussion

The analysis of Kazakhstan's transport and logistics system in 2019–2024 demonstrates a combination of positive structural changes and persistent systemic constraints. On the one hand, the state has made progress in infrastructure modernisation, the introduction of digital technologies, and a gradual transition toward environmentally sustainable logistics. On the other hand, the sector still faces barriers that limit competitiveness and reduce the effectiveness of Kazakhstan's role as a transit hub [8].

Over the last five years, Kazakhstan has significantly expanded and modernized its transport infrastructure. Within the framework of the Nurly Zhol program, large transit routes were reconstructed, including the Western Europe–Western China corridor, which reduced cargo delivery times. Railway stations were upgraded, and the capacity of Aktau Seaport increased, strengthening Kazakhstan's position as a key transit link. At the same time, integration into international transport routes (Figure 1) has become one of the main drivers of freight turnover growth, ensuring more stable economic ties with foreign partners [9].

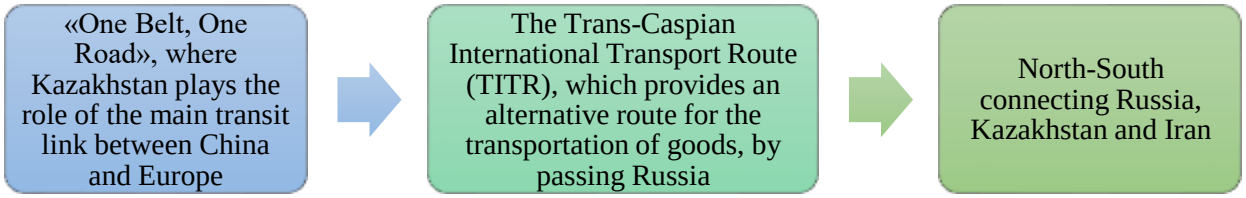

Figure 1 – Transport routes of the Republic of Kazakhstan [9]

Note: Compiled by the authors

The development of digital logistics solutions has become an important priority. Between 2019 and 2024, Kazakhstan introduced electronic document management systems, intelligent transportation technologies, and blockchain-based platforms for cargo tracking. The Digital Kazakhstan program contributed to the automation of customs procedures, significantly accelerating transit operations, minimising bureaucratic delays, and reducing transaction costs. However, the share of digitalisation in the overall investment structure remains modest, which slows the pace of technological modernisation.

Another critical trend is the gradual shift toward environmentally sustainable logistics. Pilot projects on electric trains and hybrid trucks were launched, and the share of multimodal transportation increased, enabling a reduction in CO_2 emissions and optimization of logistics routes.

These measures align with the global trend of green logistics and demonstrate Kazakhstan's commitment to incorporating ecological principles into its transport policy.

The analysis of freight transportation dynamics from 2019 to 2024 (Figure 2) reveals that the modal distribution remains relatively stable, with railway transport accounting for approximately 44–46%, road transport for 37–39%, and other modes occupying less than 20%. A gradual decrease in the share of rail and growth in road freight is observed, reflecting the flexibility of trucks and the expansion of regional trade. Pipeline and air transport remain at stable levels. This shift increases pressure on road infrastructure and underscores the need for a balanced development of different transportation modes [10].

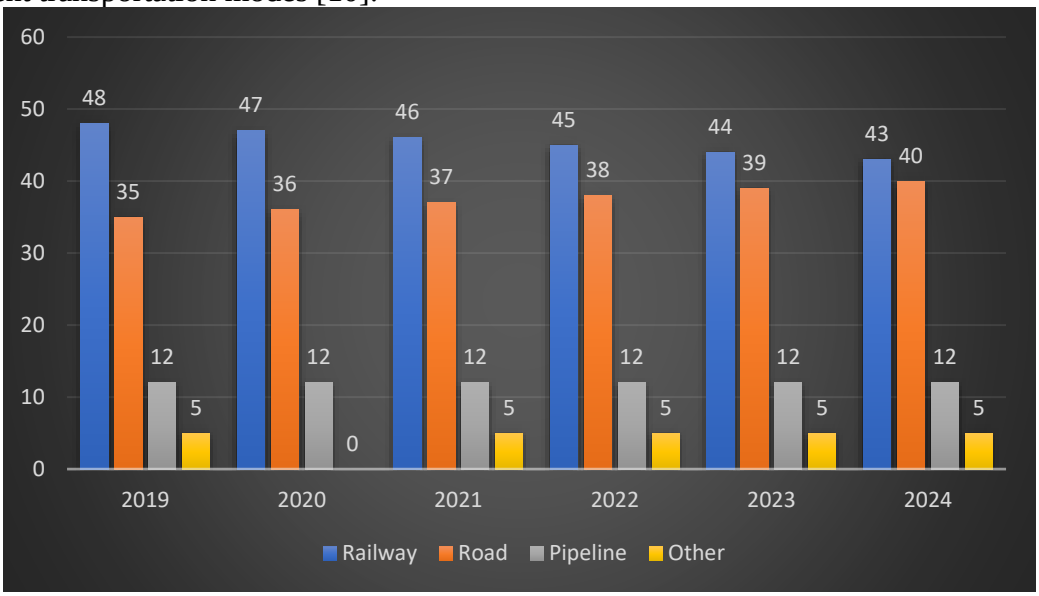

Figure 2 – Total volume of cargo transportation in Kazakhstan 2019-2024

Note: Compiled by the authors

Transit traffic (Figure 3) increased steadily, especially on the China–Europe corridor, which accounted for up to 40% of all transit volumes. At the same time, the share of routes through Russia decreased due to geopolitical restrictions, while alternative corridors such as the Trans-Caspian International Transport Route (TITR) gained importance. This restructuring confirms Kazakhstan's strategic role as a regional transit hub and reflects the reorientation of flows in response to international challenges. Economically, this creates opportunities for attracting international cargo but also requires modernization of seaports and terminals [11].

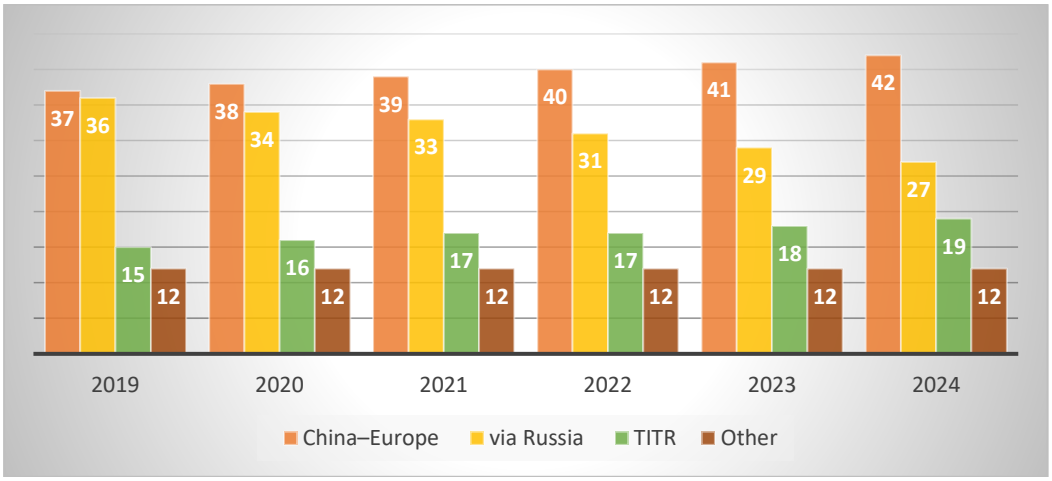

Figure 3 – Transit traffic through Kazakhstan in the directions of 2019-2024

Note: Compiled by the authors

The dynamics of investments in transport infrastructure (Figure 4) indicate significant growth in 2023–2024, with total assets increasing by almost 50% compared to 2021. The largest share was allocated to railway modernization and road construction, while financing of digitalization projects remains disproportionately low. This imbalance creates a risk of technological lag: although infrastructure is expanding, the insufficient integration of IT solutions and green technologies may reduce competitiveness in the long term [12].

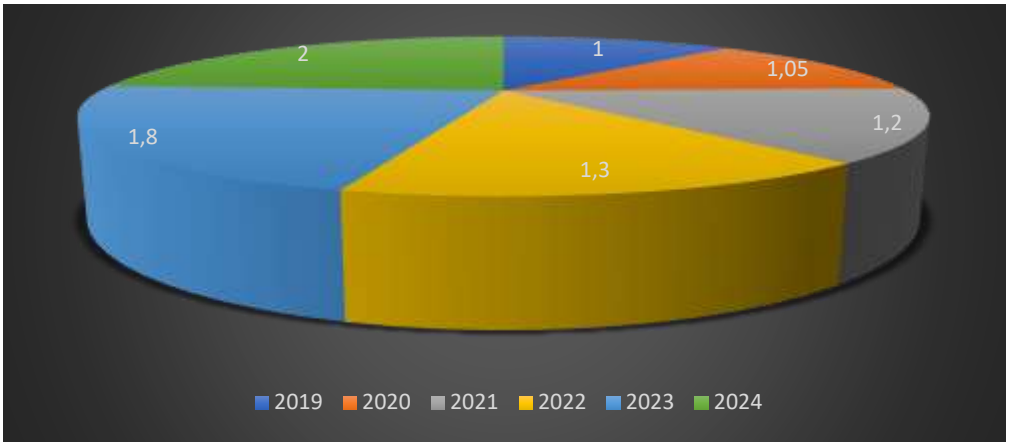

Figure 4 – Investments in the transport industry of Kazakhstan 2019-2024 (Trillion KZT)
Note: Compiled by the authors

Freight turnover in railway transport (Figure 5) reflects Kazakhstan's growing role as a transit state. The share of international transit increased steadily, while domestic freight turnover remained stable. Export transportation showed fluctuations depending on global commodity markets but did not undergo significant structural changes. This underlines the importance of diversification and reliance on transit flows as a stable growth factor.

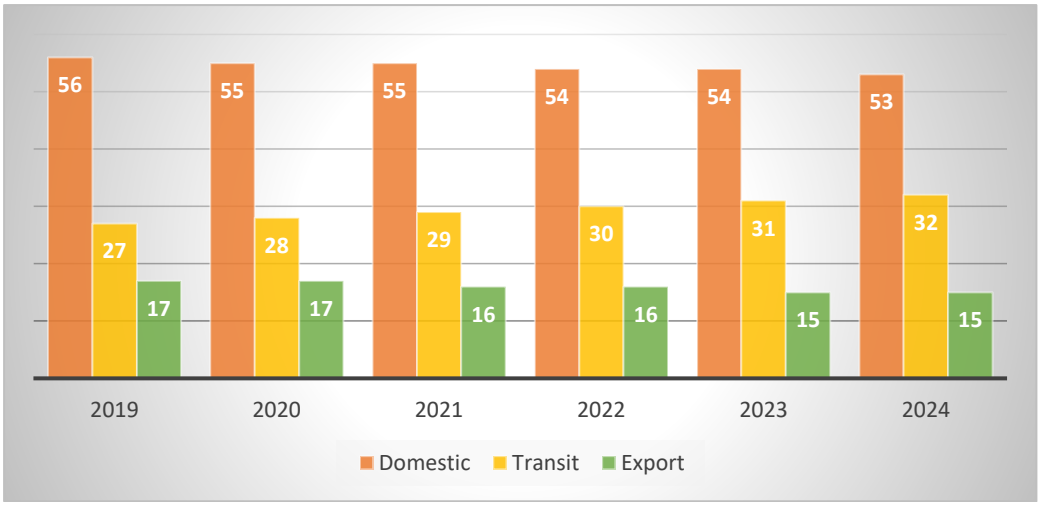

Figure 5 – Freight turnover of railway transport by destination 2019-2024
Note: Compiled by the authors

The main barriers to logistics development are summarized in Figure 6. The results of expert surveys conducted in 2023–2024 indicate that 35% of specialists name the physical deterioration of infrastructure as the primary constraint, 25% emphasize the shortage of qualified personnel, 20% highlight insufficient digitalization, and another 20% point to the underdevelopment of logistics hubs. These findings confirm that, despite investment growth, the system still requires comprehensive modernization.

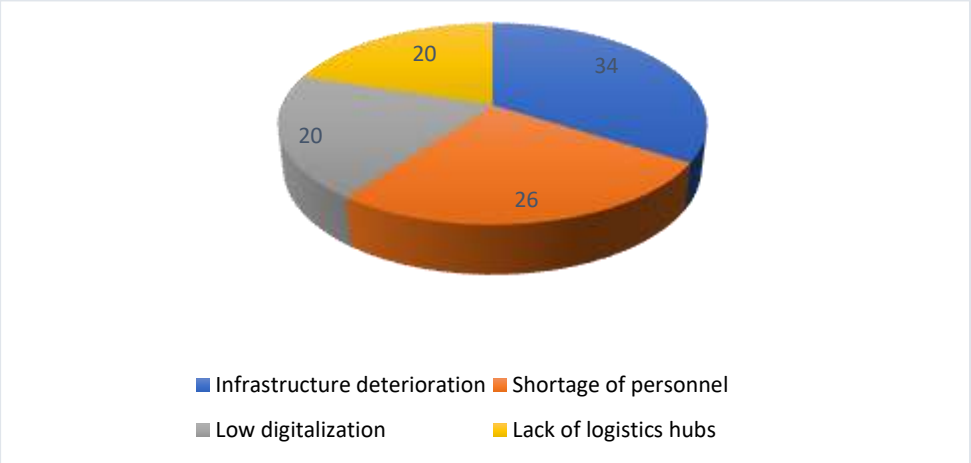

Figure 6 – The main problems of logistics in Kazakhstan

Note: Compiled by the authors

Table 1 presents the dynamics of Kazakhstan's transport indicators in 2019–2024, which demonstrate stable growth in cargo transportation, a 31% increase in transit volumes, and a 50% rise in investments in 2023.

Table 1 – Dynamics of transport system indicators in Kazakhstan (2019-2024)

Indicator	2019	2020	2021	2022	2023	2024	Trend
Cargo transportation volume, million tons	830	815	860	861	895	910	steady growth
Transit traffic, million tons	18	20	22	24	29	31	+72% (2019-2024)
Investments in transport, trillion tenge	1.0	1.1	1.2	1.2	1.8	2.0	+100% (2019-2024)
Railway cargo turnover, billion t-km	220.1	225.0	233.4	245.2	252.0	260.5	upward trend
Note: Compiled by the authors							

1. Kazakhstan has strengthened its position in global transit due to the diversification of transport corridors and integration into China–Europe flows.

2. Investment growth in 2023–2024 demonstrates state priorities, but insufficient financing of digitalization remains a weak point.

3. The gradual shift toward road freight indicates the need for balancing the modal system to prevent overloading of highways.

4. The transition to green logistics and multimodal transport confirms Kazakhstan's adaptation to global sustainability trends, though projects remain at the pilot stage.

5. Expert assessments reveal systemic barriers (infrastructure wear, personnel shortage, insufficient hubs), which require coordinated reforms.

Thus, the results of the analysis for 2019–2024 prove that Kazakhstan's logistics system is developing dynamically but remains dependent on external challenges and internal limitations. Achieving sustainable development requires a balance between infrastructure expansion, digital transformation, and ecological modernization.

Recommendations:

Based on the conducted analysis, the following recommendations can be proposed for the sustainable development of Kazakhstan's transport and logistics system:

1. Accelerate digitalization – expand investments in IT platforms, electronic customs systems, and smart transport technologies to eliminate technological gaps.

2. Develop multimodal logistics hubs – integrate rail, road, air, and maritime infrastructure to improve connectivity and reduce bottlenecks.

3. Strengthen transit corridors – prioritize the development of the Trans-Caspian International Transport Route and diversify transit flows to reduce dependence on traditional routes.

4. Introduce green logistics practices – expand the use of electric and hybrid vehicles, as well as eco-standards for freight companies, to reduce environmental impact.

5. Enhance human capital – strengthen professional training and education in logistics and supply chain management to address the shortage of qualified personnel.

6. Ensure balanced investment policy – alongside infrastructure expansion, allocate sufficient resources for digital transformation and environmental projects.

Conclusion

During the analysis of the transport and logistics system of the Republic of Kazakhstan in 2019–2024, the main development trends, structural strengths, and systemic barriers were identified. Kazakhstan's favorable geographical position at the intersection of Eurasian transport corridors provides it with significant transit potential. It allows the country to play a strategic role in ensuring stable cargo flows between China, Europe, Russia, and Central Asia.

The results of the study confirm that transit traffic volumes steadily increased during the analyzed period, with the China–Europe corridor accounting for the largest share. At the same time, a reorientation of flows toward alternative routes, particularly the Trans-Caspian International Transport Corridor, has been observed due to geopolitical changes. This demonstrates Kazakhstan's growing importance as a flexible regional logistics hub capable of adapting to external challenges.

The modal structure of transportation remained relatively stable: railway transport consistently accounts for 44–46% of the total cargo volume due to its high throughput and cost efficiency, while road transport represents 37–39%, serving regional and short-distance routes. Pipeline, air, and water transport collectively account for around 15%, without significant structural fluctuations. This balance highlights the resilience of the transport system, while also underscoring the need for modal diversification and multimodal integration.

Investment activity shows a positive upward trend. Between 2019 and 2024, the total investment in transport infrastructure nearly doubled, with the most significant growth occurring in 2023–2024. Priority was given to the modernization of railways and highways, while financing for digitalization projects remains disproportionately low (less than 10% of the total). This creates a risk of technological lag, highlighting the necessity of expanding investments in digital platforms, smart logistics, and automation.

At the same time, the study revealed systemic barriers that hinder the effective functioning of the logistics sector. Among the most pressing are the deterioration of infrastructure, shortage of qualified specialists, limited development of modern logistics hubs, and slow pace of digitalization. These constraints reduce Kazakhstan's competitiveness as a transit country and limit the effectiveness of integration into global supply chains.

Thus, despite clear positive dynamics in cargo volumes and infrastructure investments, Kazakhstan still faces significant challenges. Achieving sustainable progress requires a balanced approach: modernization of physical infrastructure, acceleration of digital transformation, development of green and multimodal logistics, strengthening of human resources and professional competencies.

Only through such an integrated strategy can Kazakhstan fully realize its transit potential, enhance its role in the international logistics network, and ensure long-term competitiveness of the national economy.

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ТҰРАҚТЫ ДАМУ ЖАҒДАЙЫНДАҒЫ ҚАЗАҚСТАННЫҢ КӨЛІК-ЛОГИСТИКАЛЫҚ ЖҮЙЕСІНІҢ МӘСЕЛЕЛЕРІ ЖӘНЕ БОЛАШАҒЫ

Андатпа

Мақалада Қазақстан Республикасының 2019-2024 жылдардағы көлік-логистикалық жүйесінің жұмыс істеуі мен дамуы қарастырылған. Зерттеу статистикалық мәліметтерге, халықаралық тәжірибелермен салыстырмалы талдауға, сараптамалық бағалауға және негізгі дәліздердің картографиялық визуализациясына негізделген. Мұндай көп әдісті тәсіл саладағы сандық көрсеткіштерді де, сапалық өзгерістерді де бағалауға мүмкіндік берді. Талдау Қазақстанның Еуразиялық сауда ағындарының тоғысқан жерінде стратегиялық тұрғыдан тиімді позицияны иеленетінін көрсетеді, бұл оның негізгі транзиттік торап ретіндегі рөлін алдын ала анықтайды. 2019-2024 жылдар аралығында транзит көлемі, әсіресе Қытай–Еуропа дәлізі бойында айтарлықтай өсті, бұл елдің халықаралық логистикалық желілердегі өзектілігінің артып келе жатқанын растайды. Сонымен қатар, жүк тасымалының модальді таралуы салыстырмалы түрде тұрақты болып қалды, теміржол және автомобиль көлігі тұрақты түрде басым болды.

Инвестициялық белсенділік 2023-2024 жылдары күрт өскенін көрсетті, бұл ретте қаражат бірінші кезекте теміржол және автомобиль инфрақұрылымын жаңғыртуға бағытталды. Дегенмен, цифрлық шешімдер мен экологиялық инновацияларды қаржыландыру деңгейі қарапайым болып қалды. Бұл теңгерімсіздік ұзақ мерзімді тәуекелдерді тудырады, өйткені жаһандық логистикалық тенденциялар "жасыл" трансформациялар мен цифрлық платформалар арқылы көбірек қалыптасуда. Мультимодальды және экологиялық таза көліктегі пилоттық жобалар іске қосылды, бірақ олардың ауқымы жүйелік өзгерістерді қамтамасыз ету үшін әлі де жеткіліксіз.

Зерттеу сонымен қатар негізгі құрылымдық шектеулерді атап өтті: инфрақұрылымның нашарлауы, білікті мамандардың жетіспеушілігі, логистикалық орталықтардың дамымауы және цифрландырудың жеткіліксіздігі. Бұл факторлар жетекші транзиттік экономикалармен салыстырғанда Қазақстанның бәсекеге қабілеттілігін төмендетеді.

Бұл зерттеудің жаңалығы тұрақты салалық дамудың әлеуетті стратегияларын анықтауға мүмкіндік беретін бірыңғай аналитикалық шеңберде инвестициялар динамикасын, цифрландыруды және экологиялық басымдықтарды байланыстыруда жатыр. Қорытындылардың практикалық маңыздылығы олардың дәліздерді әртараптандыруды, жүк тасымалдау режимдерін теңгерімді бөлуді және цифрлық және экологиялық таза логистиканы мақсатты түрде ілгерілетуді қоса алғанда, саясатты әзірлеу мен бизнес стратегияларына қолданылуында жатыр.

Негізгі сөздер: көлік-логистикалық жүйе, инфрақұрылымды жаңғырту, цифрландыру, жасыл логистика, инвестиция

ПРОБЛЕМЫ И ПЕРСПЕКТИВЫ ТРАНСПОРТНО-ЛОГИСТИЧЕСКОЙ СИСТЕМЫ КАЗАХСТАНА В УСЛОВИЯХ УСТОЙЧИВОГО РАЗВИТИЯ

Аннотация

В данной статье рассматривается функционирование и развитие транспортно-логистической системы Республики Казахстан в период 2019-2024 годов. Исследование основано на статистических данных, сравнительном анализе с международной практикой, экспертных оценках и картографической визуализации основных коридоров. Такой многометодный подход позволил оценить как количественные показатели, так и качественные преобразования в отрасли. Анализ показывает, что Казахстан занимает стратегически выгодное положение на перекрестке евразийских торговых потоков, что предопределяет его роль ключевого транзитного узла. В период с 2019 по 2024 год объемы транзитных перевозок значительно возросли, особенно по коридору Китай–Европа, что подтверждает растущую значимость страны в международных логистических сетях. В то же время распределение грузовых перевозок по видам транспорта остается относительно стабильным, при этом преобладают железнодорожный и автомобильный транспорт.

Инвестиционная активность резко возросла в 2023-2024 годах, при этом средства в основном были направлены на модернизацию железнодорожной и автодорожной инфраструктуры. Однако уровень финансирования цифровых решений и экологических инноваций оставался скромным. Этот дисбаланс создает долгосрочные риски, поскольку глобальные тенденции в области логистики все в большей степени определяются "зеленой" трансформацией и цифровыми платформами. Были запущены пилотные проекты в области мультимодальных и экологически чистых перевозок, но их масштаб по-прежнему недостаточен для обеспечения системных изменений.

Исследование также выявило ключевые структурные ограничения: износ инфраструктуры, нехватку квалифицированных специалистов, неразвитость логистических центров и недостаточную цифровизацию. Эти факторы снижают конкурентоспособность Казахстана по сравнению с ведущими транзитными экономиками.

Новизна данного исследования заключается в увязке динамики инвестиций, цифровизации и экологических приоритетов в рамках единой аналитической базы, что позволяет определить потенциальные стратегии устойчивого отраслевого развития. Практическая значимость полученных результатов заключается в их применимости к разработке политики и бизнес-стратегий, включая диверсификацию коридоров, сбалансированное распределение видов грузовых перевозок и целенаправленное продвижение цифровой и экологически чистой логистики.

Ключевые слова: транспортно-логистическая система, модернизация инфраструктуры, цифровизация, зеленая логистика, инвестиции

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Information about authors:

Elmira Dosmuratova - **corresponding author**, 2nd-year doctoral student at the M. Auezov State University, 160000, Shymkent, Republic of Kazakhstan

E-mail: 639kz@mail.ru

ORCID: https://orcid.org/0009-0000-8302-6799

Roza Niyazbekova - doctor of economic science, professor of the Department "Economics", M.Auezov South Kazakhstan University, 160000, Shymkent, Republic of Kazakhstan

E-mail: roza.niyazbekova@auezov.edu.kz

ORCID: https://orcid.org/0000-0001-6666-0456

Diyor Karimov - PhD, Associate Professor, National University of Uzbekistan named after Mirzo Ulugbek, 100012, Tashkent, Republic of Uzbekistan.

E-mail: karimov.diyor65@gmail.com

ORCID: https://orcid.org/ 0000-0002-6050-1806

Информация об авторе

Эльмира Досмуратова - **основной автор,** докторант 2 курса Южно-Казахстанского университета имени М.Ауэзова, 160000, г. Шымкент, Республика Казахстан

E-mail: 639kz@mail.ru

ORCID: https://orcid.org/0009-0000-8302-6799

Роза Ниязбекова - доктор экономических наук, профессор кафедры «Экономика», Южно-Казахстанский университет имени М.Ауэзова, 160000, г. Шымкент, Республика Казахстан

E-mail: roza.niyazbekova@auezov.edu.kz

ORCID: https://orcid.org/0000-0001-6666-0456

Диер Каримов - PhD, доцент, Национальный университет Узбекистана им. Мирзо Улугбека, 100012, г.Ташкент, Республика Узбекистан

E-mail: karimov.diyor65@gmail.com

ORCID: https://orcid.org/0000-0002-6050-1806

Авторлар туралы ақпарат:

Эльмира Досмұратова - **негізгі автор,** 2 курс докторанты, М. Әуезов атындағы Оңтүстік Қазақстан университеті, 160000, Шымкент қ., Қазақстан Республикасы,

E-mail: 639kz@mail.ru

ORCID: https://orcid.org/0009-0000-8302-6799

Роза Ниязбекова – экономика ғылымдарының докторы, «Экономика» кафедрасының профессоры, М.Әуезов атындағы Оңтүстік Қазақстан университеті, 160000, Шымкент қ., Қазақстан Республикасы

E-mail: roza.niyazbekova@auezov.edu.kz

ORCID: https://orcid.org/0000-0001-6666-0456

Диер Кәрімов - PhD, доцент, Мирзо Ұлықбек атындағы Өзбекстан ұлттық университеті, 100012, Ташкент қ., Өзбекстан Республикасы

E-mail: karimov.diyor65@gmail.com

ORCID: https://orcid.org/0000-0002-6050-1806