

N.Kh. Maulina*, **A. K. Bekmetova**,
A.B. Asanova, **LSh. Kunshigarova**

Al-Farabi Kazakh National University, Almaty, Kazakhstan

*e-mail: nurgul.maulina.79@mail.ru

DIGITALISATION IN LOGISTICS: OPPORTUNITIES FOR DIVERSIFYING RISKS IN THE REPUBLIC OF KAZAKHSTAN

The article addresses the issue of diversifying logistics risks affecting the transport and logistics system of the Republic of Kazakhstan. The relevance of the study is determined by the need to enhance the resilience of the national logistics system amid geopolitical instability, sanctions, infrastructure wear, currency fluctuations, inflationary pressure, rising tariffs, cyber threats, and labor shortages. The aim of the study is to identify the main types of logistics risks in Kazakhstan and to scientifically substantiate the possibilities of digitalisation and innovative approaches to their mitigation. The study employed methods of statistical, comparative, and expert analysis. The empirical base included official statistical data, industry reports, indicators of inflation, currency exchange rates, transport tariffs, as well as actual data on railway, urban bus, and air transport for the years 2021–2024.

As a result of the study, the main risks affecting Kazakhstan's logistics system have been systematized, and the interconnections of geopolitical, economic, infrastructural and digital factors have been identified. The scientific contribution of the article lies in considering logistics risks as a system of complex factors affecting the resilience of the national transport system. The practical significance is determined by proposals aimed at digitalisation, infrastructure renewal, the development of alternative routes and strengthening cybersecurity.

Keywords: logistics, risks, transport, infrastructure, economy, digitalization, cybersecurity, investments, transit.

Н.Х. Маулина*, А.К. Бекметова,
А.Б. Асанова, Л.Ш. Куншигарова

Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан

*e-mail: nurgul.maulina.79@mail.ru

Логистикадағы цифрландыру: Қазақстан Республикасындағы тәуекелдерді әртараптандыру мүмкіндіктері

Мақалада Қазақстан Республикасының көлік-логистика жүйесіне әсер ететін логистикалық тәуекелдерді әртараптандыру мәселесі қарастырылады. Зерттеудің өзектілігі геосаяси тұрақсыздық, санкциялық шектеулер, инфрақұрылымдық тозу, валюта бағамының ауытқуы, инфляциялық қысым, тарифтердің өсуі, киберқауіптер мен кадр тапшылығы жағдайында ұлттық логистикалық жүйенің тұрақтылығын күшейту қажеттілігімен айқындалады. Зерттеудің мақсаты – Қазақстандағы логистикалық тәуекелдердің негізгі түрлерін анықтау және оларды төмендетуде цифрландыру мен инновациялық тәсілдердің мүмкіндіктерін ғылыми тұрғыдан негіздеу.

Зерттеу барысында статистикалық, салыстырмалы және сараптамалық талдау әдістері қолданылды. Эмпирикалық база ретінде 2021–2024 жылдардағы ресми статистикалық деректер, салалық есептер, инфляция, валюта бағамы, көлік тарифтері және теміржол, қалалық автобус, әуе көлігі салалары бойынша нақты көрсеткіштер пайдаланылды.

Зерттеу нәтижесінде Қазақстанның логистикалық жүйесіне әсер ететін негізгі тәуекелдер жүйеленіп, геосаяси, экономикалық, инфрақұрылымдық және цифрлық факторлардың өзара байланысы айқындалды. Мақаланың ғылыми үлесі логистикалық тәуекелдерді ұлттық көлік жүйесінің тұрақтылығына әсер ететін кешенді факторлар жүйесі ретінде қарастыруында. Практикалық маңызы цифрландыру, инфрақұрылымды жаңғырту, баламалы маршруттарды дамыту және киберқауіпсіздікті күшейтуге бағытталған ұсыныстармен анықталады.

Түйін сөздер: логистика, тәуекелдер, көлік, инфрақұрылым, экономика, цифрландыру, киберқауіпсіздік, инвестициялар, транзит.

Н.Х.Маулина*, А.К. Бекметова,
А.Б.Асанова, Л.Ш.Куншигарова

Казахский национальный университет имени аль-Фараби, Алматы, Казахстан

*e-mail: nurgul.maulina.79@mail.ru

Цифровизация в логистике: возможности диверсификации рисков в Республике Казахстан

В статье рассматривается вопрос диверсификации логистических рисков, влияющих на транспортно-логистическую систему Республики Казахстан. Актуальность исследования определяется необходимостью усиления устойчивости национальной логистической системы в условиях геополитической нестабильности, санкционных ограничений, износа инфраструктуры, колебаний валютного курса, инфляционного давления, роста тарифов, киберугроз и нехватки кадров. Цель исследования – определить основные виды логистических рисков в Казахстане и научно обосновать возможности цифровизации и инновационных подходов в их снижении.

В ходе исследования использовались методы статистического, сравнительного и экспертного анализа. В качестве эмпирической базы были использованы официальные статистические данные, отраслевые отчёты, показатели инфляции, валютного курса, транспортных тарифов, а также реальные показатели по железнодорожному, городскому автобусному и воздушному транспорту за 2021–2024 годы.

В результате исследования систематизированы основные риски, влияющие на логистическую систему Казахстана, выявлены взаимосвязи геополитических, экономических, инфраструктурных и цифровых факторов. Научный вклад статьи заключается в рассмотрении логистических рисков как системы комплексных факторов, влияющих на устойчивость национальной транспортной системы. Практическое значение определяется предложениями, направленными на цифровизацию, обновление инфраструктуры, развитие альтернативных маршрутов и усиление кибербезопасности.

Ключевые слова: логистика, риски, транспорт, инфраструктура, экономика, цифровизация, кибербезопасность, инвестиции, транзит.

Introduction

The transport and logistics system of the Republic of Kazakhstan constitutes a strategically significant sector that ensures the country's sustainable economic development and determines its international transit potential. Kazakhstan's geographical position between Europe and Asia positions it as a key link within major international transport corridors. Nevertheless, in the current context, the functioning of the national logistics system is significantly influenced by geopolitical instability, sanctions constraints, transformations in global trade routes, inflationary pressures, rising transportation tariffs, infrastructural limitations, and ongoing processes of digital transformation.

Under these conditions, the issue of managing and diversifying logistical risks has become particularly relevant. Although existing scholarly literature addresses the modernization of transport infrastructure, the development of transit corridors, and the digitalization of logistics, a comprehensive and systematized assessment of logistical risks in Kazakhstan—considering the interdependence of geopolitical, economic, infrastructural, and techno-

logical factors—remains insufficiently developed. In this regard, the central research problem of this study lies in identifying the key risks affecting the stability of Kazakhstan's transport and logistics system and substantiating effective directions for their diversification.

The object of the study is the transport and logistics system of the Republic of Kazakhstan. The subject of the study encompasses the geopolitical, economic, infrastructural, and technological risks affecting the stability of this system, as well as the mechanisms for their mitigation. The main research question is formulated as follows: what are the dominant risks influencing Kazakhstan's logistics system under current conditions, and which diversification strategies can enhance national transit resilience?

The aim of the study is to conduct a comprehensive analysis of the key risks within Kazakhstan's logistics system and to provide a scientific justification for priority directions of their diversification. To achieve this aim, the following tasks are addressed: assessing the current state of the logistics system; identifying the principal categories of risks; analyzing their interrelationships and im-

pack levels; and developing practical recommendations to improve the stability of the transport and logistics system.

The scientific novelty of the study lies in conceptualizing logistical risks within the specific transport and transit context of Kazakhstan as an integrated, multi-factor system. The paper proposes a structured classification of risks into interconnected geopolitical, economic, infrastructural, and technological blocks. The practical significance of the research is determined by the applicability of its findings to the improvement of transport and logistics policy, the prioritization of infrastructure development, the diversification of transport corridors, the implementation of digital solutions, and the enhancement of investment strategies.

Literature Review

Changes in transport service tariffs are widely recognized in contemporary economic and logistics research as a critical factor influencing macroeconomic stability, social accessibility, and the competitiveness of national economies (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009; Tang, 2006). Empirical evidence from various countries demonstrates that transportation costs have a direct impact on inflation, the final prices of goods and services, the accessibility of mobility for the population, and the overall logistics expenses of businesses (Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (BNS), 2025; OECD, 2023; World Bank, 2023). In this context, examining the mechanisms underlying tariff formation in rail, urban bus, and aviation sectors is of both theoretical and practical importance.

Studies focusing on rail transport indicate that tariff increases are largely driven by infrastructure depreciation, rising energy costs, and the necessity of rolling stock modernization. Sultanbek *et al.* (2024) & Bepaly (2023) associate tariff dynamics with increasing capital repair expenditures and infrastructural constraints (Rygzynov *et al.*, 2023; Taisarinova *et al.*, 2020). According to the International Union of Railways (UIC, 2022), higher electricity and fuel prices constitute key determinants of rising freight and passenger tariffs (BNS, 2025; World Bank, 2023). Additionally, World Bank (2023) and OECD (2023) emphasize the role of government subsidies, regulatory frameworks, and management efficiency in shaping

tariff policies. While these studies provide valuable sector-specific insights, their scope remains largely confined to the railway domain.

In the case of urban bus transport, the literature primarily links tariff growth to increasing operational costs (Naumov *et al.*, 2022). Reports by the OECD (2023) and Bureau of National Statistics (2025) identify fuel price volatility as a principal driver of fare increases in urban mobility systems. The World Bank (2024) further highlights the impact of rising driver wages, higher maintenance costs, and investments in environmentally sustainable transport solutions, such as electric buses, on tariff formation. National-level studies by Bureau of National Statistics (2025) and Bureau of National Statistics (2025) attribute increases in public transport fares in Kazakhstan to insufficient government subsidies, low profitability of transport services, and the need for fleet renewal (BNS, 2025; Tazhiyev *et al.*, 2024). However, these analyses tend to address tariff changes in isolation, without integrating them into a broader logistics risk framework.

In the aviation sector, tariff dynamics are influenced by factors such as aviation fuel prices, airport fee structures, international restrictions, and increasing operational costs. Industry reports by IATA (2023) and ICAO (2024) emphasize the central role of fuel price escalation and airport service charges in driving airfare increases. IATA (2023) further underline the indirect effects of international sanctions, particularly in limiting access to affordable fuel, spare parts, and supply chains—an issue that is especially critical for countries with developing aviation infrastructure. National reports from the Nurlanuly & Shalbolova (2024) also confirm that rising airline operating costs and the need to subsidize domestic routes contribute significantly to tariff growth.

Overall, the existing body of literature provides a substantial understanding of the determinants of tariff changes across different modes of transport. Nevertheless, most studies adopt a sector-specific perspective, analyzing rail, bus, or aviation transport independently. As a result, the interconnections between economic, infrastructural, institutional, and technological drivers of tariff changes are not sufficiently conceptualized within a unified logistics system framework (Kabashkin & Sansyzybayeva, 2024; Mamrayeva *et al.*, 2022; Zhao *et al.*, 2023). Furthermore, the broader implications of tariff dynamics for national transport system resilience

and transit potential remain underexplored (Biró & Vasa, 2024; Palu & Hilmola, 2023; Rentschler *et al.*, 2025; Yermekbayev *et al.*, 2024).

A critical review of the literature reveals a significant gap in the comprehensive analysis of transport tariff changes within the context of integrated logistics risk systems, particularly in the case of Kazakhstan. Existing studies either generalize international experiences or focus narrowly on specific transport sectors (Bespalyy, 2023; IATA, 2023; OECD, 2023; Sultanbek *et al.*, 2024). Consequently, tariff dynamics are rarely examined as a systemic phenomenon shaped by the interaction of geopolitical, economic, infrastructural, and technological factors.

Moreover, transport tariffs are typically treated as isolated economic indicators, rather than as components of a broader framework influencing national transit resilience, logistics stability, and risk diversification strategies (Biró & Vasa, 2024; Palu & Hilmola, 2023; Rentschler *et al.*, 2025; Yermekbayev *et al.*, 2024). This limitation defines the conceptual space addressed by the present study (BNS, 2025; OECD, 2023; Sultanbek *et al.*, 2024).

This paper aims to address the identified gap by providing a comprehensive and comparative analysis of transport tariff dynamics across rail, bus, and aviation sectors within the broader context of Kazakhstan's logistics system (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009; Tang, 2006). Rather than examining tariff changes in isolation, the study situates them within an integrated risk environment affecting national transport and transit stability (Mamrayeva *et al.*, 2022; Zhao *et al.*, 2023).

The main contributions of the study are as follows:

First, the determinants of tariff changes are systematically classified into economic, infrastructural, institutional, and technological categories.

Second, similarities and differences in tariff dynamics across various transport modes are identified through comparative analysis.

Third, tariff changes are explicitly linked to the issue of logistics risk diversification, providing a more holistic analytical perspective.

Fourth, the study utilizes data from the period 2024–2025 to assess short-term trends in tariff dynamics and their implications for the national transport and logistics system (BNS, 2025; IATA, 2023; Nurlanuly & Shalbolova, 2024; Sultanbek *et al.*, 2024; Tazhiyev *et al.*, 2024).

The theoretical contribution of this research lies in reconceptualizing transport tariff dynamics not merely as an economic variable, but as a multifactorial phenomenon influencing the resilience of logistics systems. This approach enables the analysis of tariff policies beyond cost fluctuations, incorporating their relationships with infrastructural constraints, regulatory frameworks, digital transformation processes, and external geopolitical pressures (Kabashkin & Sansyzbayeva, 2024; Mamrayeva *et al.*, 2022; Zhao *et al.*, 2023).

By integrating tariff dynamics into the broader theory of logistics risks, the study offers a comprehensive analytical framework for understanding how tariff changes affect national transit systems (Christopher & Peck, 2004; OECD, 2023; Ponomarov & Holcomb, 2009; Tang, 2006). This perspective extends existing theoretical approaches and contributes to the advancement of logistics research in the context of emerging economies such as Kazakhstan (Biró & Vasa, 2024; Palu & Hilmola, 2023; Rygzynov *et al.*, 2023; Taisarinova *et al.*, 2020; World Bank, 2023; Yermekbayev *et al.*, 2024).

The selection of the 2024–2025 period as the focus of analysis is both theoretically and practically justified. This timeframe allows for the examination of short-term fluctuations in transport tariffs driven by fuel price volatility, infrastructure modernization, public subsidy policies, and digital reforms (BNS, 2025; Nurlanuly & Shalbolova, 2024; Sultanbek *et al.*, 2024; Tazhiyev *et al.*, 2024). It also provides an opportunity to observe immediate outcomes of policy changes and to formulate evidence-based forecasts for the near future (Biró & Vasa, 2024; Rentschler *et al.*, 2025).

The efficiency and sustainability of transport corridors depend on the interaction of infrastructure, operational processes, and system-level constraints (Kabashkin & Sansyzbayeva, 2024).

In summary, although the issue of transport tariff growth has been extensively examined in both international and national literature, a comprehensive analysis linking tariff dynamics to the broader system of logistics risks remains insufficiently developed in the context of Kazakhstan. This study seeks to fill this gap by offering an integrated, system-oriented perspective that connects tariff changes with logistics stability, risk diversification strategies, and transport policy effectiveness (Bespalyy, 2023; Kabashkin &

Sansyzbayeva, 2024; Naumov *et al.*, 2022; World Bank, 2023; Zhao *et al.*, 2023).

Methodology

This study was aimed at comprehensively assessing the risks arising within the logistics system of the Republic of Kazakhstan, identifying their internal structure, and proposing scientifically grounded mechanisms for their diversification. The methodological framework of the study is based on the principle of examining geopolitical, economic, infrastructural, and technological factors affecting the stability of the logistics system in their interconnection and continuity. Kazakhstan's location within the important transit space between Europe and Asia, the growing significance of its role in international transport corridors, and the volatile transformations in the external environment necessitate an in-depth, systemic rather than superficial analysis of logistics risks. In this regard, the study conceptualizes logistics risks not as a set of isolated factors, but as a multilayered phenomenon directly influencing the stability and efficiency of the country's transport and transit system.

During the research process, official statistical materials, industry reports, analytical reviews, publications of international organizations, and both domestic and foreign scholarly literature were extensively employed. The information base was formed from the data of the Bureau of National Statistics of the Republic of Kazakhstan, the Ministry of Transport of the Republic of Kazakhstan, the National Bank of the Republic of Kazakhstan, and the national company Kazakhstan Temir Zholy, as well as open data from international financial and development institutions. In particular, reports and analytical materials from the World Bank, the International Monetary Fund, the Asian Development Bank, the European Bank for Reconstruction and Development, and UN system bodies related to transport and trade were used. Supply chain digitalization enhances resilience and operational performance by improving information sharing, coordination, and responsiveness across logistics networks (Zhao *et al.*, 2023).

In developing the theoretical section of the study, scholarly works devoted to logistics, transport geography, risk management, infrastructure modernization, digitalization, and the functioning of international transport corridors were employed. For the empirical analysis, open statistical and sectoral

data on exchange rate dynamics, inflation levels, changes in transport tariffs, investment activity, transit volumes, the throughput capacity of ports and railway networks, the technical condition of transport infrastructure, and the transformation of international logistics routes were systematized. The integration of such heterogeneous sources made it possible to evaluate the research object comprehensively from macroeconomic, institutional, and sectoral perspectives.

The study was conducted on the basis of data covering the period from 2021 to 2024. The selection of this period is determined by several scientific and applied considerations. First, this time span encompasses the processes of economic adaptation and recovery in the post-pandemic period. Second, it was during these years that the complication of the geopolitical situation, the intensification of sanctions pressure, the reconfiguration of international transport routes, and the volatility of commodity and energy markets exerted a substantial influence on Kazakhstan's logistics system. Third, significant institutional and infrastructural initiatives aimed at modernizing transport infrastructure, strengthening transit capacity, and digitalizing logistics processes were implemented during this period.

In addition, to clarify the current development trends of specific indicators, available statistical data from early 2025 were also taken into account as supplementary comparative and reference material. Defining the temporal boundaries in this way made it possible to reveal not only the current dynamics of logistics risks but also the specific features of their structural transformation.

The study employed a comprehensive analytical approach combining quantitative and qualitative methods. Within the framework of quantitative analysis, methods of statistical comparison, examination of time series, structural and comparative analysis, indicator-based assessment, graphical interpretation, and scientific generalization were applied. These methods made it possible to identify the trends in the temporal evolution of the main indicators affecting the logistics system, as well as their interrelationships and risk implications. In particular, such indicators as exchange rate fluctuations of the tenge, inflationary processes, changes in transport service tariffs, investment volumes, the workload of international routes, and infrastructure throughput were examined from dynamic and comparative perspectives.

Within the scope of qualitative analysis, content analysis, systems analysis, comparative-expert analysis, factor-based interpretation, and methods of risk grouping were used. Content analysis enabled the systematization of key conclusions contained in scholarly publications, strategic documents, and official reports, while systems analysis created the conditions for examining the causes of logistics risk formation and their impact on the transport and transit system in their interdependence. In addition, within the framework of the study, logistics risks were classified into geopolitical, economic, infrastructural, and technological-digital categories, and the content, channels of influence, and mechanisms of impact of each group were analyzed.

If an expert approach was employed in the study, the selection of experts was carried out on the basis of purposiveness and professional relevance. The group of experts included specialists with experience in logistics, transport infrastructure, customs regulation, digital transformation, transport economics, and transit policy. The main selection criteria included at least five years of professional experience in logistics, transport, or infrastructure; experience in managerial, analytical, or research activities related to the topic of the study; practical work experience in public, quasi-public, or private sector structures; in-depth knowledge of specific issues within the transport and logistics system; as well as competence in interpreting sectoral data and assessing risk situations.

Expert opinions were used to уточнить the degree of significance of logistics risks, to rank them according to priority, and to evaluate the practical effectiveness of measures aimed at risk diversification. When combined with statistical data, this approach enhances the substantive depth of the research results and makes it possible to align them more closely with the actual sectoral context.

The study was carried out through several interrelated stages. At the first stage, the theoretical and methodological foundations of the research were established. At this stage, scholarly literature and strategic documents concerning logistics risks, transport corridors, infrastructural constraints, digitalization, transit sustainability, and external economic influences were reviewed, and the objective, tasks, object, subject, and analytical logic of the study were clarified.

At the second stage, the empirical base was accumulated and systematized. Official statistical materials, industry reports, macroeconomic

indicators, data describing the condition of transport infrastructure, and information related to the operational characteristics of international routes were selected. At this stage, particular attention was paid to the reliability of information sources, their substantive consistency, and their comparability.

At the third stage, the collected materials were subjected to quantitative and qualitative analysis. The degree of influence of such factors as exchange rate changes, inflationary pressure, tariff growth, infrastructural congestion, investment activity, and the level of digitalization on logistics stability was determined. Dynamic and comparative analysis methods served as the principal research tools at this stage.

At the fourth stage, a systematized classification of logistics risks was developed. Risks were grouped into geopolitical, economic, infrastructural, and technological-digital categories, and their preconditions of emergence, channels of dissemination, and probable consequences were identified. Such classification made it possible to gain a deeper understanding of the internal structure of risks and to substantiate their interdependence from a scientific perspective.

At the fifth stage, based on the results obtained, the priority directions for diversifying risks within Kazakhstan's logistics system were identified. These included expanding transport routes, developing alternative corridors, modernizing infrastructure, introducing digital solutions, strengthening cybersecurity, expanding public-private partnership, and stimulating investment activity. The proposed recommendations were formulated not on the basis of general descriptive judgments, but by relying on the specific system of risk factors identified during the analysis.

The methodological approach employed in the study makes it possible to examine Kazakhstan's logistics system within a multifactor and multilevel environment. Its principal advantage lies in the integration of official statistical data, expert judgments, and systematic scientific interpretation, which together make it possible to reveal comprehensively the sources of logistics risks, the mechanisms of their influence, and the possibilities for their mitigation. This approach not only strengthens the scientific validity of the study but also enhances its practical significance.

Thus, the proposed methodology makes it possible to identify the risks inherent in Kazakhstan's transport and logistics system, assess

the dynamics of their development, and formulate scientifically grounded conclusions and recommendations aimed at strengthening the resilience of the system under conditions of both external and internal challenges.

Results and discussion

Diversification of logistical risks is an important task for Kazakhstan in an unstable global economy. The development of new routes, modernization of infrastructure, digitalization and cooperation with international partners will increase the sustainability of the transport industry and reduce potential threats. This will provide Kazakhstan with competitive advantages in global logistics chains and strengthen its role as a key transport hub in Eurasia (Palu & Hilmola, 2023).

Geopolitical risks

Kazakhstan depends on transit routes through neighboring countries such as Russia and China. Sanctions and trade barriers pose a threat to supply stability. In this regard, alternative routes are being developed, for example, the Trans-Caspian International Transport Route (TMTM).

Kazakhstan is located in a strategically important region and depends on transit routes through neighboring countries such as Russia, China and Central Asian countries. Geopolitical instability, sanctions, and trade barriers pose a threat to supply stability.

The main risks include:

- Sanctions restrictions. The imposition of sanctions against Russia makes it difficult to use traditional routes, requiring the development of alternative routes.
- Political tensions in neighboring countries. Conflicts or changes in the political landscape of neighboring countries can affect trade routes.
- Energy dependence. Kazakhstan exports significant amounts of oil and gas through neighboring countries, which creates risks in the event of a change in the political environment.
- The Trans-Caspian International Transport Route (TMTM). The development of alternative routes across the Caspian Sea reduces dependence on traditional routes, but requires significant investments.

Infrastructure constraints

Despite the active development of transport infrastructure, projects such as the modernization of railways (Dostyk – Moynty) and the construction of

highways (BAKAD) require significant investments. Their successful implementation reduces infrastructure risks. There are a number of problems that actively affect the logistical stability of Kazakhstan:

- Deterioration and congestion of railway networks. The main railway routes of the country require modernization. In 2022-2025, work is underway to upgrade the Dostyk–Moynty section, but overloading remains a problem.

- The lack of modern logistics hubs. Kazakhstan is actively developing logistics centers in Nur-Sultan, Almaty and Aktobe, but their number and level of equipment are still inferior to international standards.

- Limited capacity of the road network. Highways are being developed through projects such as the Greater Almaty Ring Road (BAKAD), but the lack of high-quality highways increases transportation costs.

- Port infrastructure development. Kazakhstan relies on the Trans-Caspian route, but the ports of Aktau and Kuryk require additional investments to increase capacity.

- Air logistics. Airports in Nur-Sultan and Almaty are being upgraded, but problems remain with regional airports that limit the flexibility of cargo transportation.

Economic risks

In the period from 2021 to 2024, Kazakhstan's economy faced a number of significant economic risks that significantly affected the country's logistics sector. Below is a detailed analysis of the key factors, supported by relevant graphs. Fluctuations in the tenge exchange rate, inflation and changes in freight tariffs have an impact on logistics companies and export-import operations. Diversification of financing sources and the development of private investment help to reduce these risks.

Economic factors have a significant impact on the logistics industry in Kazakhstan. Over the past four years (2021-2024), the following key risks have been identified:

- Fluctuations in the tenge exchange rate.
- Inflation.
- Increased transportation tariffs.
- Lack of investment in the industry.

Fluctuations in the tenge exchange rate

The exchange rate of the national currency, the tenge, has undergone significant changes over the specified period. In November 2024, the exchange rate exceeded 500 tenge per US dollar, which

became an important psychological frontier for the country's economy.

Data for the period 2021–2024 indicate a weakening trend of the national currency. According to the data presented in the text, in November 2024 the exchange rate of the US dollar exceeded 500 tenge, while in 2022 the tenge depreciated by 10–15%. This change was considered a key macroeconomic indicator reflecting the increase in logistics costs that depend on imports.

Assuming that in 2022 the tenge depreciated by 12%, with the base exchange rate $y_0 = 450$ tenge, the new exchange rate is calculated as follows:

$$y_t = 450 \times (1 + 0.12) = 504$$

Thus, the absolute change is:

$$\Delta y = 504 - 450 = 54$$

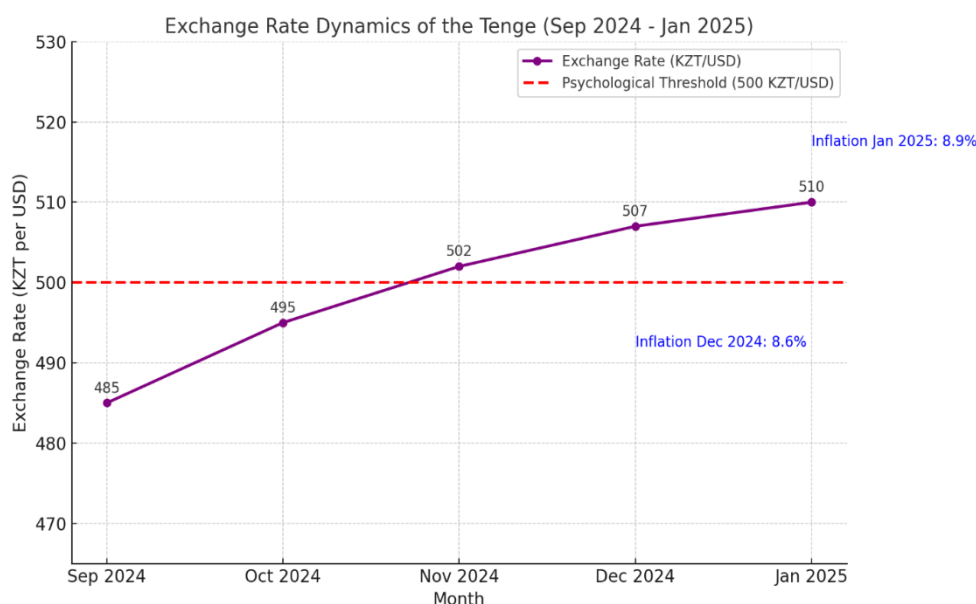
The growth rate is:

$$T_p = \frac{504 - 450}{450} \times 100\% = 12\%$$

This calculation demonstrates that the weakening of the national currency increases the cost of imported fuel, spare parts, logistics equipment, and digital solutions. Therefore, exchange rate fluctuations should be regarded not as an indirect factor, but as a direct cost-forming determinant for the logistics sector. In the case of Kazakhstan, this is especially significant for segments dependent on external supplies, imported equipment, and international transport infrastructure.

Thus, figure 1 does not merely illustrate changes in the exchange rate; it also provides macroeconomic evidence of the growing risk of higher logistics costs.

Figure 1
Dynamics of the tenge exchange rate against the US dollar



Note: Compiled by the authors

The devaluation of the national currency increases the cost of imports and transportation services, which affects prices for end users. In 2022, the tenge weakened by 10–15% due to sanctions pressure and instability of global markets.

The tenge-US dollar exchange rate for the period 2021–2024 shows a tendency to weaken the national

currency. The main factors influencing this dynamic:

1. Global economic shocks – the impact of sanctions, inflationary processes in world economies, and market instability.
2. Oil Prices – Kazakhstan's economy is heavily reliant on commodities, making oil price

fluctuations a key factor influencing the tenge exchange rate.

3. Inflation and Monetary Policy – Rising domestic inflation and the National Bank of the Republic of Kazakhstan's interventions to regulate the money supply.

4. Geopolitical risks – sanctions against neighboring countries, changes in trade routes and investment flows.

A weakening tenge can drive up the cost of imported goods and services, including logistics. Measures are needed to diversify the economy and reduce dependence on exports of raw materials. The development of domestic production facilities and transport infrastructure can reduce the risks associated with currency fluctuations.

Inflation

According to the data collected from the research, inflation reached 14–16% in 2022–2023, while in January 2025 the annual inflation was 8.9%, inflation reached 14–16% during 2022–2023, while in January 2025 the annual inflation rate was recorded at 8.9%. In addition, the increase from 8.6% in December 2024 to 8.9% in January 2025 indicates that price pressures persisted even in the short term.

The increase in inflation between December 2024 and January 2025 is calculated as:

$$\Delta y = 8.9 - 8.6 = 0.3$$

The relative growth rate is:

$$T_p = \frac{8.9 - 8.6}{8.6} \times 100\% \approx 3.49\%$$

Structural analysis

The main components of inflation are distributed as follows:

- paid services – 13.8%
- non-food goods – 8.4%
- food products – 5.8%

The total value is:

$$13.8 + 8.4 + 5.8 = 28.0$$

Thus, the proportional shares are calculated as:
Paid services:

$$U_1 = \frac{13.8}{28.0} \times 100\% = 49.3\%$$

Non-food goods:

$$U_2 = \frac{8.4}{28.0} \times 100\% = 30.0\%$$

Food products:

$$U_3 = \frac{5.8}{28.0} \times 100\% = 20.7\%$$

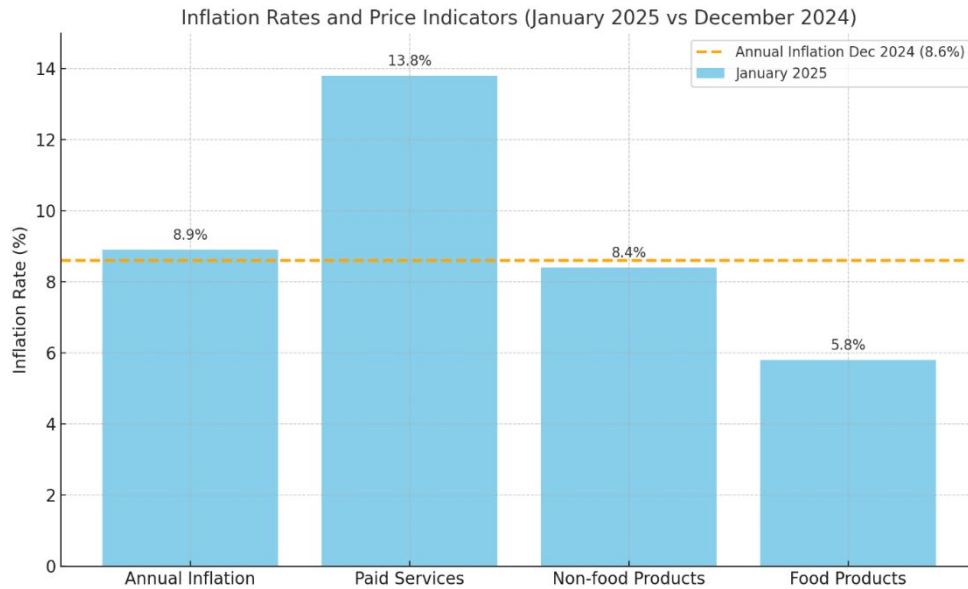
These calculations indicate that the largest share of inflationary pressure is concentrated in the paid services sector. Since logistics is directly embedded within the service economy, costs related to transportation, maintenance, technical servicing, terminal handling, and warehousing tend to increase in line with this trend.

Therefore, figure 2 demonstrates that inflation should not be viewed merely as a general macroeconomic background variable; rather, it represents a persistent driver of rising operational costs in the logistics sector. In the context of Kazakhstan, this manifests in price instability, higher delivery costs, and declining profitability for transport operators.

In 2022–2023, the inflation rate reached 14–16%, which increased the cost of transportation services, including the cost of fuel, spare parts and logistics equipment. Over the past four years, inflation in Kazakhstan has shown steady growth, factors influencing inflation:

1. Global economic trends – rising prices for energy, raw materials and food on global markets.
2. Tenge exchange rate – the weakening of the national currency leads to an increase in the cost of imports.
3. Higher fuel prices – transportation costs increase the cost of goods.
4. State monetary policy – measures to control inflation, including changes in the key rate of the National Bank.
5. Sanctions restrictions – changes in logistics chains, increase in the cost of international transportation.

Figure 2
Annual inflation in Kazakhstan



Note: Compiled by the authors

Rising inflation increases the cost of logistics services. There is a need to strengthen price control and stimulate domestic production. Investments in digitalization and optimization of logistics processes are needed to reduce costs.

Increase in transportation tariffs

Rising energy prices and inflationary pressures have driven up transport service tariffs. The analysis of changes in transport service tariffs between January 2024 and January 2025 revealed the following trends:

- rail transport: +18.6%
- urban bus transport: +10.5%
- air transport: +7.2%

These data were examined using a comparative analysis approach.

1) Comparative differences by mode of transport

The difference between rail and bus transport:

$$18.6 - 10.5 = 8.1$$

The difference between rail and air transport:

$$18.6 - 7.2 = 11.4$$

The difference between bus and air transport:

$$10.5 - 7.2 = 3.3$$

2) Average tariff increase

$$\bar{x} = \frac{18.6 + 10.5 + 7.2}{3} = \frac{36.3}{3} = 12.1\%$$

3) Structural shares

Total growth value:

$$18.6 + 10.5 + 7.2 = 36.3$$

Share of rail transport:

$$U_{rail} = \frac{18.6}{36.3} \times 100\% \approx 51.2\%$$

Share of bus transport:

$$U_{bus} = \frac{10.5}{36.3} \times 100\% \approx 28.9\%$$

Share of air transport:

$$U_{air} = \frac{7.2}{36.3} \times 100\% \approx 19.8\%$$

4) Example of estimating the impact on logistics costs

If the initial cost of freight transportation by rail is 1,000,000 tenge, after a tariff increase of 18.6%, the new cost will be:

$$L_c = 1,000,000 \times \left(1 + \frac{18.6}{100}\right)$$

$$L_c = 1,000,000 \times 1.186 = 1,186,000$$

Additional cost:

$$1,186,000 - 1,000,000 = 186,000$$

Similarly, for bus transport with an initial cost of 500,000 tenge:

$$L_c = 500,000 \times 1.105 = 552,500$$

Additional cost:

$$52,500$$

For air transport with an initial cost of 2,000,000 tenge:

$$L_c = 2,000,000 \times 1.072 = 2,144,000$$

Additional cost:

$$144,000$$

These calculations clarify the key implications of Figure 3. Since the highest tariff growth is observed in rail transport, this sector generates the greatest pressure on Kazakhstan's logistics system, given its strong dependence on rail-based freight flows.

An 18.6% increase in rail tariffs does not only raise transportation costs for operators but also affects export prices, domestic market prices, warehouse turnover, and overall transit attractiveness. The rise in urban bus tariffs increases the social burden, while higher air transport tariffs elevate the cost of both international and interregional connectivity.

Thus, figure 3 demonstrates that tariff pressure is unevenly distributed across transport modes, with

the highest concentration of logistics risk occurring in the rail sector.

In 2023, tariffs for rail and road transport increased by 12-20% due to rising fuel and lubricants costs and infrastructure fees. The data show that the largest increase in tariffs was recorded in rail transportation (18.6%), followed by urban bus transport (10.5%) and the smallest increase in aviation (7.2%).

The main influencing factors:

1. Railway transport:

- Increase in fuel and electricity costs.
- Infrastructure deterioration requiring modernization.

• Rising maintenance expenses for rolling stock.

• Urban Bus Transport:

- Rising fuel and spare parts costs.
- Higher wages for drivers.
- Investments in environmentally friendly transport.

3. Air transport:

- Higher prices for aviation fuel.
- Changing the fare structure at airports.
- The impact of international sanctions and logistical constraints.

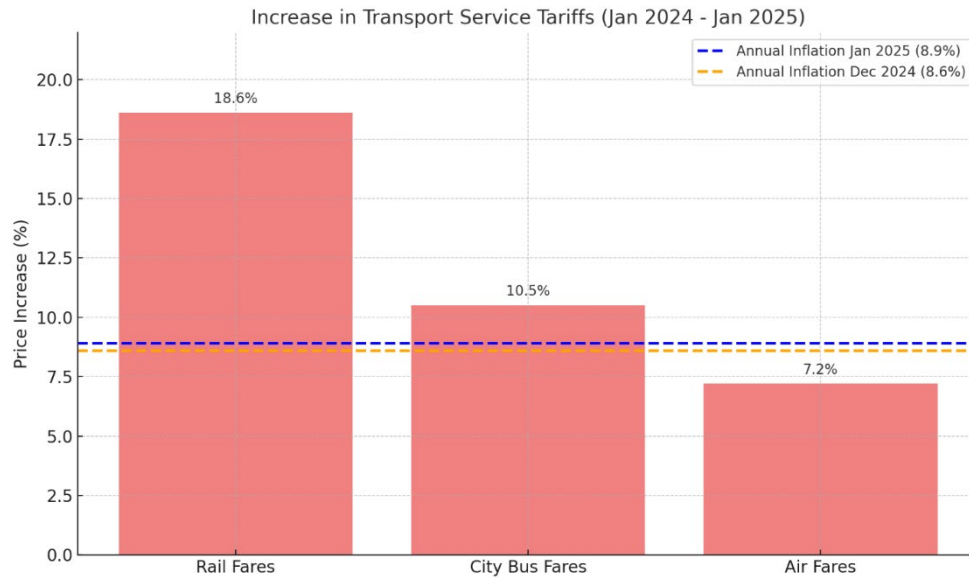
The increase in tariffs increases the transportation costs of businesses and the public. Government support measures are needed to stabilize prices. Diversification of logistics routes and cost optimization will help reduce the impact of tariff growth.

The data presented shows that insufficient investment has slowed the upgrading of logistics capacities and increased operational costs. In addition, sanctions against Russia and the slowdown of the Chinese economy have led to changes in trade flows.

Although a complete quantitative time series is not provided, the qualitative comparative analysis identifies two key conclusions:

- a shortage of investment leads to the persistence of infrastructural constraints;
- a decline in trade flows results in higher costs associated with the reconfiguration of transport routes.

Figure 3
Increase in tariffs for transportation services (January 2024 to January 2025)



Note: Compiled by the authors

These two factors demonstrate that logistics risks are not determined solely by price indicators but are also closely related to system capacity and route stability. In the context of Kazakhstan, the issue is not only the increase in tariffs, but also the limited availability of infrastructural and institutional reserves capable of absorbing these increases.

The empirical findings demonstrate that economic risks within Kazakhstan's logistics system are highly interrelated. Exchange rate depreciation increases the cost of imported inputs, inflation intensifies current operational expenditures, and tariff growth represents the cumulative manifestation of these factors within the logistics sector. In other words, tariff dynamics should not be interpreted as an isolated phenomenon; rather, they reflect the combined effects of exchange rate movements, inflationary pressures, energy costs, infrastructural constraints, and institutional limitations.

The results indicate that tariff increases are particularly pronounced in the railway sector. This is of critical importance for Kazakhstan's economy, as the country's freight turnover and transit capacity are largely dependent on rail infrastructure. Consequently, rising railway tariffs pose a direct risk to the overall stability of the national logistics system.

The structural composition of inflation, characterized by a high share of paid services, further reinforces the upward trend in transport and

logistics costs. This increases the likelihood of long-term cost instability within the sector. At the same time, the depreciation of the national currency raises the prices of imported equipment, spare parts, and digital systems, thereby increasing the overall cost of logistics modernization.

Taken together, these findings confirm the multi-level nature of logistics risks in Kazakhstan: at the macro level – exchange rate volatility, inflation, and geopolitical pressures; at the meso level – sectoral tariffs and investment shortages; at the micro level – operational costs and routing decisions of firms.

Conclusion

The empirical analysis conducted in this study demonstrates that the risks affecting Kazakhstan's transport and logistics system should not be viewed as isolated or independent phenomena; rather, they constitute an interconnected set of systemic factors. The findings indicate that tariff growth is largely driven by the combined influence of macroeconomic change, inflationary pressure, volatility in the national currency exchange rate, rising energy costs, and infrastructural constraints. From this perspective, transport tariff dynamics should be interpreted not merely as a sector-specific issue, but as a complex risk indicator reflecting the resilience of the national logistics system.

The results also reveal that the level of risk is uneven across transport modes. The greatest tariff pressure was observed in the railway sector, which can be explained by its dominant role in Kazakhstan's freight turnover structure, the high degree of infrastructure deterioration, and the substantial share of energy-related costs. These conditions justify treating railway transport as the principal concentration point of national logistics risks. In urban bus transport, tariff increases intensify the social burden and directly affect public access to transport services, whereas in the aviation sector, tariff growth influences interregional connectivity and the spatial cohesion of the domestic market.

The analysis further confirms that inflation and exchange-rate fluctuations exert a direct impact on logistics costs. Depreciation of the national currency increases the cost of imported fuel, spare parts, transport equipment, and digital technologies. At the same time, inflationary pressure raises the current operating costs of transport services. As a result, the cost base of transport operations expands, creating the preconditions for further tariff increases. Therefore, measures aimed at reducing logistics risks should be considered not only at the sectoral governance level, but also within the broader framework of macroeconomic stabilization.

Based on the discussion of the research findings, several practical recommendations can be proposed to strengthen the resilience of Kazakhstan's transport and logistics system. First, in the railway sector, it is necessary to implement long-term investment programs aimed at modernizing trunk infrastructure. Such measures would increase network capacity, reduce repair costs, and mitigate the tariff pressure associated with infrastructure wear and degradation. In addition, targeted subsidy mechanisms should be introduced to reduce carriers' operating costs, support energy expenditures, facilitate rolling stock renewal, and maintain socially significant transport services.

Second, in urban passenger transport, the social consequences of fare increases require a reconsideration of public transport subsidy policy. Subsidy instruments should be redesigned on the basis of a flexible model that takes into account the interests of specific social groups as well as the expenditure structure of transport operators. At the same time, improving fuel compensation mechanisms, renewing the vehicle fleet on a phased basis, and promoting a transition toward environmentally

sustainable modes of transport would strengthen the long-term stability of the urban mobility system.

Third, in the air transport sector, stronger measures are needed to preserve the affordability of domestic flights, including selective subsidization and support for strategically important regional routes. In addition, optimizing the structure of airport charges, revising service tariffs, and implementing managerial solutions aimed at improving airlines' operational efficiency are essential. These measures would not only reduce the cost of air transport but also help ensure the continuity of regional connectivity.

Fourth, at the level of general logistics policy, priority should be given to the diversification of transport routes. In this regard, the development of the Trans-Caspian International Transport Route, the expansion of alternative transit corridors, and the reduction of dependence on external markets are of strategic importance. At the same time, the introduction of digital platforms, the use of Big Data-based analytical tools, and the development of intelligent transport systems can enhance transparency in transport processes and reduce operational inefficiencies. To strengthen the digital resilience of the logistics system, investment in cybersecurity infrastructure and the training of sector-specific digital professionals should also be treated as priority directions.

Thus, the results of the study show that the risks inherent in Kazakhstan's transport and logistics system are complex and multi-level in nature, and that their mitigation requires an integrated and coordinated policy approach. The practical measures proposed in this paper are aimed at reducing the negative effects associated with rising transport tariffs, improving the operational efficiency of the logistics system, and strengthening Kazakhstan's transit and infrastructural resilience. In turn, this would enhance the country's competitiveness within international supply chains and contribute to long-term economic stability.

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Conflict of Interest

The authors declare that there are no conflicts of interest that could have influenced the results of the study or their interpretation.

Author Contributions

NKhM & AKB: conceptualization, methodology, software, validation, project administration.

LShK: formal analysis, data curation, project administration.

ABA: investigation, resources, writing – original draft preparation, writing – review & editing, visualization.

All authors have read and agreed to the published version of the manuscript.

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Information about authors:

Maulina Nurgul Khasanovna – correspondent-author, Candidate of Economic Sciences, Associate Professor of the 'Business Technologies' Department at Al-Farabi KazNU, (Almaty, Republic of Kazakhstan, e-mail: nurgul.maulina.79@mail.ru).

Bekmetova Aruna Kerneevna – PhD student, 'Business Technologies' Department at Al-Farabi KazNU (Almaty, Republic of Kazakhstan, e-mail: aruna_67@mail.ru).

Asanova Altynai Bolysova – Candidate of Economic Sciences, Associate Professor of the 'Finance and Accounting' Department at Al-Farabi KazNU, (Almaty, Republic of Kazakhstan, e-mail: altin_assan@bk.ru).

Kunshigarova Lyazzat Shaugarbaevna – Candidate of Economic Sciences, Kazakh National Agrarian Research University, (Almaty, Republic of Kazakhstan, e-mail: Lyazzat-82@mail.ru).

Авторлар туралы мәліметтер:

Маулина Нургул Хасанқызы – (корреспондент-автор), экономика ғылымдарының кандидаты, әл-Фараби атындағы ҚазҰУ «Бизнес технологиялары» кафедрасының доценті, (Алматы қ., Қазақстан Республикасы, e-mail: nurgul.maulina.79@mail.ru).

Бекметова Аруна Кернейқызы – докторант, әл-Фараби атындағы ҚазҰУ «Бизнес технологиялары» кафедрасы (Алматы қ., Қазақстан Республикасы, e-mail: aruna_67@mail.ru).

Асанова Алтынай Болысқызы – экономика ғылымдарының кандидаты, әл-Фараби атындағы ҚазҰУ «Қаржы және есеп» кафедрасының доценті, (Алматы қ., Қазақстан Республикасы, e-mail: altin_assan@bk.ru).

Куншигарова Ляззат Шаукарбаевна – экономика ғылымдарының кандидаты, Қазақ ұлттық аграрлық зерттеу университеті, (Алматы қ., Қазақстан Республикасы, e-mail: Lyazzat-82@mail.ru).

Информация об авторах:

Маулина Нургуль Хасановна – корреспондент-автор, кандидат экономических наук, доцент кафедры «Бизнес-технологии» КазНУ имени аль-Фараби, (г. Алматы, Республика Казахстан, e-mail: nurgul.maulina.79@mail.ru).

Бекметова Аруна Кернеевна – докторант, кафедра «Бизнес-технологии» КазНУ имени аль-Фараби (г. Алматы, Республика Казахстан, e-mail: aruna_67@mail.ru).

Асанова Алтынай Болысовна – кандидат экономических наук, доцент кафедры «Финансы и учет» КазНУ имени аль-Фараби, (г. Алматы, Республика Казахстан, e-mail: altin_assan@bk.ru).

Куншигарова Ляззат Шаукарбаевна – кандидат экономических наук, Казахский национальный аграрный исследовательский университет, (г. Алматы, Республика Казахстан, e-mail: Lyazzat-82@mail.ru).

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