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THE CURRENT STATE OF THE INFRASTRUCTURE OF THE AIRPORTS OF THE REPUBLIC OF KAZAKHSTAN

*I. Asilbekova, G. Muratbekova, Z. Konakbai**
Academy of Civil Aviation, Almaty, Kazakhstan.
E-mail: z.konakbai@agakaz.kz

Indira Asilbekova — c.t.s., Academy of Civil Aviation, Almaty, Kazakhstan

E-mail: a.indira71@mail.ru, <https://orcid.org/0009-0009-8988-9910>;

Gulzhan Muratbekova — c.t.s., Academy of Civil Aviation, Almaty, Kazakhstan

E-mail: g.muratbekova@alt.edu.kz, <https://orcid.org/0009-0003-0005-0470>;

Zarina Konakbai — c.t.s., Academy of Civil Aviation, Almaty, Kazakhstan

E-mail: z.konakbai@agakaz.kz, <https://orcid.org/0009-0002-4370-9397>.

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Abstract. The article presents a comprehensive analysis of the current state and development of airport infrastructure in the Republic of Kazakhstan, which is a key element of the national transport system and an important factor for the country's economic growth. Airports provide not only domestic and international mobility but also contribute to the development of tourism, international trade, and Kazakhstan's integration into the global transport network. In recent years, passenger and cargo air traffic volumes have increased significantly, creating higher demands for airport infrastructure modernization and implementation of international safety standards, including ICAO and IATA. The aim of the study is to assess the current state of Kazakhstan's airport infrastructure, identify problem areas, and develop strategic directions for its further development. The research objectives include examining the technical condition of runways and terminals, analyzing airport management efficiency, conducting comparative analysis with international practices, determining modernization priorities, and developing recommendations to enhance the sector's competitiveness. The results revealed a high level of wear in regional airport infrastructure, insufficient modern equipment, a significant concentration of passenger flow in three major aviation hubs, and low private investment attraction. The analysis also highlighted the need for digital technology integration, management optimization, and implementation of public-private partnership mechanisms. Sustainable development of Kazakhstan's airport network is achievable through comprehensive infrastructure modernization, implementation of international safety standards, digitalization of processes, and investment stimulation, which will improve passenger service quality, ensure effective management of the aviation sector, and strengthen the country's position as a transport hub between Europe and Asia.

Keywords: airport, infrastructure, safety, air transportation, modernization, Kazakhstan, transport

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ҚАЗАҚСТАН РЕСПУБЛИКАСЫ ӘУЕЖАЙЛАРЫНЫҢ ИНФРАҚҰРЫЛЫМЫНЫҢ АҒЫМДАҒЫ ЖАЙ-КҮЙІ

*И. Асильбекова, Г. Муратбекова, З. Қонақбай**

Азаматтық авиация академиясы, Алматы, Қазақстан.

E-mail: z.konakbai@agakaz.kz

Индира Асильбекова — т.ғ.к., Азаматтық авиация академиясы, Алматы, Қазақстан

E-mail: a.indira71@mail.ru, <https://orcid.org/0009-0009-8988-9910>;

Гульжан Муратбекова — т.ғ.к., Азаматтық авиация академиясы, Алматы, Қазақстан

E-mail: g.muratbekova@alt.edu.kz, <https://orcid.org/0009-0003-0005-0470>;

Зарина Қонақбай — т.ғ.к., Азаматтық авиация академиясы, Алматы, Қазақстан

E-mail: z.konakbai@agakaz.kz, <https://orcid.org/0009-0002-4370-9397>.

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Аннотация. Мақала Қазақстан Республикасының әуежайларының инфрақұрылымының қазіргі жағдайын және дамуын кешенді талдауға арналған. Әуежайлар ұлттық транспорт жүйесінің негізгі элементі болып табылады және елдің экономикалық өсіміне маңызды әсер етеді. Олар тек ішкі және халықаралық халық қозғалысын қамтамасыз етіп қана қоймай, туризмнің, халықаралық сауданың дамуына және Қазақстанның әлемдік транспорт желісіне интеграциясына үлес қосады. Соңғы жылдары жолаушылар мен жүк әуе тасымалы көлемдері айтарлықтай өсті, бұл әуежай инфрақұрылымын жаңарту мен халықаралық қауіпсіздік стандарттарын, соның ішінде ICAO және IATA стандарттарын енгізу қажеттілігін арттырды. Зерттеудің мақсаты – Қазақстан әуежайлары инфрақұрылымының қазіргі жағдайын бағалау, проблемалық аймақтарды анықтау және оның дамуының стратегиялық бағыттарын анықтау. Зерттеу міндеттеріне ұшу-қону жолағы мен терминалдардың техникалық жағдайын зерттеу, әуежайларды басқару тиімділігін талдау, халықаралық тәжірибемен салыстырмалы талдау жасау, жаңартудың басым бағыттарын анықтау және сала бәсекеге қабілеттілігін арттыру бойынша ұсыныстар әзірлеу кіреді. Зерттеу нәтижелері өңірлік әуежай инфрақұрылымының едәуір тозғанын, заманауи жабдықтардың жетіспейтінін, жолаушылар ағымының үш ірі авиаузелде шоғырланғанын және жеке инвестицияларды тарту деңгейінің төмен екенін көрсетті. Анализ сондай-ақ цифрлық технологияларды интеграциялау, басқаруды оңтайландыру және мемлекеттік-жекешелік серіктестік механизмдерін енгізу қажеттілігін анықтады. Қазақстан әуежай желісінің тұрақты дамуы инфрақұрылымды кешенді жаңарту, халықаралық қауіпсіздік стандарттарын енгізу, процестерді цифрландыру және инвестицияларды ынталандыру арқылы мүмкін, бұл жолаушыларға қызмет көрсету сапасын арттырады, авиация саласын тиімді басқарады және елдің Еуропа мен Азия арасындағы транспорт хабы ретіндегі позициясын нығайтады.

Түйін сөздер: әуежай, инфрақұрылым, қауіпсіздік, әуе тасымалы, жаңарту, Қазақстан, көлік

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ТЕКУЩЕЕ СОСТОЯНИЕ ИНФРАСТРУКТУРЫ АЭРОПОРТОВ РЕСПУБЛИКИ КАЗАХСТАН

*И. Асильбекова, Г. Муратбекова, З. Қонақбай**

Академия гражданской авиации, Алматы, Казахстан.

E-mail: z.konakbai@agakaz.kz

Индира Асильбекова — к.т.н., Академия гражданской авиации, Алматы, Казахстан

E-mail: a.indira71@mail.ru, <https://orcid.org/0009-0009-8988-9910>;

Гульжан Муратбекова — к.т.н., Академия гражданской авиации, Алматы, Казахстан

E-mail: g.muratbekova@alt.edu.kz, <https://orcid.org/0009-0003-0005-0470>;

Зарина Қонақбай — к.т.н., Академия гражданской авиации, Алматы, Казахстан

E-mail: z.konakbai@agakaz.kz, <https://orcid.org/0009-0002-4370-9397>.

© И. Асильбекова, Г. Муратбекова, З. Қонақбай

Аннотация. Статья посвящена комплексному анализу состояния и развития инфраструктуры аэропортов Республики Казахстан, которые являются ключевым элементом национальной транспортной системы и важным фактором экономического роста страны. Аэропорты обеспечивают не только внутреннюю и международную мобильность населения, но и способствуют развитию туризма, международной торговли и интеграции Казахстана в мировую транспортную сеть. За последние годы объёмы пассажирских и грузовых авиаперевозок значительно увеличились, что создаёт повышенные требования к модернизации аэропортовой инфраструктуры и внедрению международных стандартов безопасности, включая ИКАО и IATA. Цель исследования заключается в оценке текущего состояния инфраструктуры аэропортов Казахстана, выявлении проблемных зон и разработке стратегических направлений её дальнейшего развития. В задачи исследования включены изучение технического состояния взлётно-посадочных полос и терминалов, анализ эффективности управления аэропортами, сравнительный анализ с международными практиками, определение приоритетов модернизации и разработка рекомендаций по повышению конкурентоспособности отрасли. Результаты исследования показали высокий износ инфраструктуры региональных аэропортов, недостаточное оснащение современным оборудованием, значительную концентрацию пассажиропотока в трёх крупнейших авиаузлах и низкий уровень привлечения частных инвестиций. Анализ также выявил потребность в интеграции цифровых технологий, оптимизации управления и внедрении механизмов государственно-частного партнёрства. Устойчивое развитие аэропортовой сети Казахстана возможно при комплексной модернизации инфраструктуры, внедрении международных стандартов безопасности, цифровизации процессов и стимулировании инвестиций, что обеспечит повышение качества обслуживания пассажиров, эффективное управление авиационной отраслью и укрепление позиций страны как транспортного хаба между Европой и Азией.

Ключевые слова: аэропорт, инфраструктура, безопасность, авиаперевозки, модернизация, Казахстан, транспорт

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Introduction.

The development of airport infrastructure is one of the key directions for ensuring Kazakhstan's economic growth and its integration into the global transport system (Kazakhstan-2050 Strategy, 2012: 1–5; On Approval of the State Infrastructure Development Programme "Nurly Zhol", 2019: 2–4). Air transport plays an important role in strengthening international relations, developing tourism, and increasing population mobility. Over the past decade, the volume of passenger air transportation in Kazakhstan has increased significantly, indicating growing demand for modern and safe airports (Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan, 2024: 15–31).

Despite positive trends, the infrastructure of Kazakhstan's airports remains unevenly developed. Many regional airports are characterized by a high level of fixed asset deterioration, outdated runways, and non-compliance with international safety and service standards (Nurpeisov, 2020: 48–55). This reduces the competitiveness of the domestic aviation sector compared to neighboring countries actively investing in airport modernization, such as Russia, Turkey, and the United Arab Emirates.

The selection of this topic is conditioned by the strategic importance of airport infrastructure for the country's socioeconomic development. Airport modernization facilitates the attraction of investment, growth of tourism, and development of logistics services. Analysis of the scientific literature shows that, while individual studies addressing Kazakhstan's transport infrastructure exist, comprehensive works focused specifically on airport development are insufficiently represented.

The relevance of the topic is determined by the need to modernize and develop airports in accordance with ICAO and IATA international standards, to improve passenger service quality, and to strengthen Kazakhstan's position as a transport hub between Europe and Asia.

The object of investigation is the airport system of the Republic of Kazakhstan. The subject of investigation is the infrastructural development and modernization of Kazakhstan's airports. The aim of the research is to analyze the current state of Kazakhstan's airport infrastructure and to identify the priority directions for its further development.

The research tasks are as follows: to examine the current state and key development indicators of Kazakhstan's airports; to identify infrastructural, technical, and managerial problems constraining their operational efficiency; to analyze international experience in airport management and development; and to develop proposals for improving Kazakhstan's airport infrastructure and enhancing its competitiveness.

The research hypothesis holds that the sustainable development of Kazakhstan's airport network is achievable under conditions of infrastructure modernization based on the principles of public-private partnership, the implementation of international safety standards, and the optimization of the regional airport network.

Materials and Methods.

The methodological basis of the study comprises works by domestic and international scholars in the field of transport economics and airport infrastructure management. The study employs general scientific and specialized analytical methods, providing a comprehensive examination of the state and development directions of Kazakhstan's airport network.

The following research methods were applied: comparative analysis, enabling the comparison of Kazakhstan's airport development indicators with international standards and practices; statistical analysis, based on data from the Civil Aviation Committee of the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan and reports of the International Civil Aviation Organization (ICAO); a systems approach, facilitating the identification of relationships between the infrastructural condition of airports, air traffic volumes, and investment levels; and content analysis of regulatory documents, including government programmes for transport infrastructure development and ICAO standards governing

airport activities.

The research stages included: (1) collection and processing of data on the current state of Kazakhstan's airport infrastructure, including runway lengths, passenger and cargo traffic volumes, and technical equipment levels; (2) comparative analysis of Kazakhstan's airport indicators against international benchmarks, such as the airports of Turkey, the UAE, and Singapore, distinguished by high efficiency and service quality; (3) identification of problem areas in the functioning of domestic airports, including infrastructural constraints, investment shortfalls, and staffing challenges; and (4) formulation of recommendations for improving the competitiveness of Kazakhstan's airport network, based on international experience and sustainable development principles. The empirical base of the study rests on official statistical data from the Civil Aviation Committee, reports of the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan, ICAO documents, and materials from scientific publications addressing airport and transport infrastructure development.

Results and Discussion.

Issues related to the development and functioning of airport infrastructure have been examined in works by numerous international and domestic researchers. In the international literature, particular attention is devoted to the economic aspects of airport management, modernization, and sustainable development. Graham notes that effective airport functioning is determined not only by the technical condition of runways and terminals but also by the level of management organization, service quality, and revenue diversification (Graham, 2014: 67–74). A similar position is held by Doganis, who emphasizes that airport development must be accompanied by the optimization of financial flows and the adoption of market-based management instruments (Doganis, 2019: 95–100).

ICAO research demonstrates that improving airport efficiency is directly related to the implementation of international safety standards, digital technologies, and infrastructure monitoring systems (ICAO, 2021: 29–32). According to ICAO, sustainable airport development requires a balance between economic benefit, environmental responsibility, and social significance (ICAO, 2021: 34–39).

In the domestic scientific literature, questions of Kazakhstan's airport infrastructure development are covered less systematically. Nurpeisov notes that many regional airports operate at the limit of their technical capabilities, and the renewal of equipment and terminal reconstruction require substantial investment (Nurpeisov, 2020: 53–59). Abdrakhmanova identifies digitalization of the aviation sector, personnel development, and the adoption of innovative service technologies as key development factors (Abdrakhmanova, 2022: 41–45).

Aspanova emphasizes the need to integrate public-private partnership principles in the modernization of Kazakhstan's airports, since budget financing does not ensure the long-term sustainability of projects (Aspanova, 2025: 403–409). Similar conclusions are presented in the analytical reports of the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan (Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan, 2024: 18–20), where the development of the transport-logistics complex, including airports, is identified as a priority area of state policy.

A comparative analysis of the scientific literature reveals a research gap: most domestic publications focus on individual aspects of airport functioning — technical condition, traffic volumes, or safety issues — while comprehensive studies integrating infrastructural, economic, and managerial dimensions remain insufficiently represented (Kasymbekova et al., 2019: 99–102). The present study is directed at filling this gap and at developing scientifically grounded proposals for improving the country's airport infrastructure.

Analysis of the state of Kazakhstan's airport infrastructure (Table 1) shows that the country operates 20 international and 27 regional airports, a significant portion of which require modernization and reconstruction (Ministry of Industry and Infrastructure Development of the

Republic of Kazakhstan, 2024: 25–29). According to data from the Civil Aviation Committee, the level of runway deterioration at a number of regional airports exceeds 60 per cent, which adversely affects flight safety and capacity (Nurpeisov, 2020: 55–59).

Table 1 – Current state of Kazakhstan’s airports

Airport	Passenger flow (thou.)	Runway(s)	No. of destinations	Notes
Aktau	1,023.9 (2018)	Asphalt-concrete 3060×60 m	15	Hub of SCAT airline
Atyrau	644.6 (2016)	Asphalt 2800×70 m Asphalt-concrete 3060×60 m Unpaved 1500×100 m	10	Terminal reconstruction commenced; budget 1.5 bn KZT. Hub of Bek Air
Uralsk	220 (2018)	Cement-concrete 2800×45 m Unpaved 2800×100 m	6	
Aktobe	412.2 (2018)	Reinforced concrete 3203×45 m	6	
Kostanay	151.7 (2017)	Asphalt-concrete 2800×45 m Unpaved 2750×100 m Unpaved 1600×100 m	4	Main runway reconstruction completed; passenger throughput expected to reach 250,000/yr
Petropavlovsk	14 (2018)	Asphalt-concrete 2800×45 m	3	
Kokshetau	21.4 (2018)	Asphalt-concrete 2800×60 m	3	Official branch of Nursultan Nazarbayev International Airport
Nursultan Nazarbayev (Astana)	4,545.3 (2018)	Asphalt-concrete 3500×45 m	41 (15 domestic, 26 international)	Main airport of the Republic of Kazakhstan; hub for Air Astana and SCAT
Pavlodar	177 (2016)	Asphalt-concrete 2500×45 m	4	
Sary-Arka (Karaganda)	222.4 (2016)	Concrete 3600×60 m	6	Low-cost carrier FlyArystan planned to designate it as hub in 2020
Semey	66 (2016)	Concrete 3100×45 m Concrete 1600×100 m	4 (no intl.routes)	Terminal and runway reconstructed in 2018; total cost 10.715 bn KZT; passenger throughput expected to reach 100,000/yr
Ust-Kamenogorsk	286.6 (2016)	Asphalt-concrete 2510×43 m (to become 2800×45 m after reconstruction) Unpaved 1700×50 m	7	Runway and terminal reconstruction in progress; total project cost 10.626 bn KZT; completion expected 2021
Almaty	5,686.9 (2016)	Asphalt-concrete 4400×45 m Asphalt-concrete 4500×45 m	45 (17 domestic, 28 international)	Hub for Air Astana, SCAT, and QazaqAir
Aulie-Ata (Taraz)	63 (2018)	Asphalt-concrete 3500×60 m Unpaved 2400×100 m	3	Airport began 24-hour operations for first time in February 2019
Shymkent	817 (2018)	Concrete 3300×45 m	5	Planned passenger throughput increase to 3,500,000/yr
Korkyt Ata (Kyzylorda)	212 (2017)	Asphalt-concrete 3200×45 m Unpaved 2700×85 m	3	Reconstruction in progress; estimated cost 7.5 bn KZT

According to statistical data, between 2015 and 2023 the volume of passenger throughput through Kazakhstan's airports nearly doubled, rising from 8.7 million to 16.9 million persons (Key Socioeconomic Indicators of the Republic of Kazakhstan). The primary load falls on the three largest airports — Nursultan Nazarbayev (Astana), Almaty, and Shymkent — whose combined share amounts to approximately 72 per cent of total passenger flow (Aspanova, 2025: 406–410). Regional airports, by contrast, serve limited traffic volumes, attributable to low flight frequency, insufficient infrastructure development, and high aircraft handling costs.

The comparative analysis established that, by the level of technical equipment and service quality, Kazakhstan's airports lag behind ICAO international standards across a number of indicators. In particular, automated passenger flow control systems, modern airfield lighting equipment, and digital air traffic management systems have been implemented in fewer than 30 per cent of airports (ICAO, 2021: 37–39). For comparison, equivalent indicators at airports in Turkey and Singapore exceed 80 per cent (Graham, 2014: 115–120).

In addition, Kazakhstan maintains a high dependence of the airport sector on state financing. Despite the launch of a number of public-private partnership projects, the share of private investment in airport modernization does not exceed 25 per cent (Abdrakhmanova, 2022: 44–45). The absence of systemic incentives for investors and insufficient transparency in concession agreement procedures impede the development of regional airports (Aspanova, 2025: 407–409).

At the same time, recent years have seen positive dynamics in the modernization of major aviation hub infrastructure. An example is the reconstruction of Astana airport, where new passenger terminals have been commissioned and modern baggage processing and security control technologies have been adopted. Similar projects are being implemented at the airports of Almaty and Kyzylorda.

The research findings confirm the conclusions of international authors that airport efficiency is determined not only by the physical condition of infrastructure but also by management quality, strategic planning, and the adoption of innovations. For Kazakhstan, the key direction is the development of regional airports ensuring domestic transportation and access to remote territories.

The analysis thus identified three main problem clusters: infrastructural deterioration — a high degree of physical ageing of runways, terminals, and navigation equipment; institutional constraints — insufficient investment attractiveness of the sector and weak implementation of PPP mechanisms; and uneven development — concentration of passenger flow at three major airports, with the potential of regional airports remaining underutilized.

On the basis of the analysis conducted, the following structure of strategic tasks for Kazakhstan's airports is proposed (Figure 1):

STRATEGIC TASKS FOR AIRPORT DEVELOPMENT IN KAZAKHSTAN			
Strategic Task	Short-term	Medium-term	Long-term
1. Improve the airport network	Define airport roles and development priorities in line with Kazakhstan's national strategy and market needs		
2. Adopt international flight safety and aviation security standards	Airports must ensure safe operations, controlled and certified in accordance with international standards (ICAO/IATA)		
3. Adequate and flexible airport service level	Aerodrome and terminal expansion must always be determined by market demand	1. Airports must progressively upgrade equipment and systems to meet market needs (IATA) without disrupting effective operations 2. Ground handling rules must be amended to allow specialized ground handling agents to enter commercial relations with airlines under airport licensing	A dialogue structure among key industry stakeholders must be established for continuous comprehensive evaluation and effective infrastructure management
4. Define airport development strategy	Establish regulatory bodies with authorized rights and control; create a dialogue structure among airports, airlines, and government bodies to synchronize their strategies		

Fig. 1. Strategic tasks for airport development in Kazakhstan

The strategic tasks presented in Figure 1 reflect the necessity of a comprehensive and interconnected approach to the modernization of Kazakhstan's airport infrastructure. The conducted analysis demonstrated that the existing problems of the national airport network cannot be resolved through isolated technical reconstruction projects alone. Sustainable development requires simultaneous transformation of infrastructural, institutional, technological, financial, and managerial components of the aviation sector. In this context, the proposed structure of strategic tasks represents a systemic model aimed at ensuring the long-term competitiveness and operational sustainability of Kazakhstan's airports.

One of the central strategic directions is the modernization of airport infrastructure facilities, including runways, terminals, navigation systems, airfield lighting equipment, and ground handling complexes. Many regional airports currently operate with a high degree of physical deterioration, limiting aircraft acceptance capabilities and negatively affecting operational safety indicators. The reconstruction and extension of runways, modernization of terminal complexes, and replacement of obsolete navigation equipment are therefore essential prerequisites for increasing airport throughput capacity and ensuring compliance with ICAO and IATA standards. Modernization of infrastructure additionally creates opportunities for expanding international flight geography and attracting new air carriers.

Equally important is the task of implementing digital technologies and intelligent airport management systems. International experience demonstrates that the efficiency of modern airports increasingly depends on the level of digital integration of operational processes. The introduction of automated passenger flow management systems, biometric identification technologies, digital baggage handling systems, and intelligent dispatch coordination platforms significantly improves operational reliability and passenger service quality. Digitalization additionally enables airports to optimize resource allocation, reduce aircraft turnaround times, minimize delays, and improve overall transport efficiency.

Particular significance is attached to the development of smart airport concepts based on Industry 4.0 technologies. Within such systems, airport infrastructure functions as an integrated digital ecosystem where operational data from terminals, airfield systems, security systems, and passenger services are processed in real time using artificial intelligence and big data analytics. The implementation of predictive maintenance systems for airport equipment and infrastructure allows early identification of technical failures and optimization of maintenance schedules, thereby reducing operational risks and infrastructure downtime.

Another key strategic task concerns the attraction of private investment and expansion of public-private partnership (PPP) mechanisms. The conducted analysis showed that excessive dependence on state financing constrains the pace of modernization projects and limits opportunities for technological renewal, especially in regional airports. International practice demonstrates that PPP mechanisms are among the most effective instruments for financing large-scale infrastructure projects. Their implementation allows the state to reduce budgetary burden while enabling private investors to participate in airport management, construction, and operation. However, for PPP mechanisms to function effectively in Kazakhstan, it is necessary to improve the legal framework governing concession agreements, ensure transparency of investment procedures, and establish long-term guarantees for investors.

An important strategic direction is the balanced development of regional airport infrastructure. At present, the majority of passenger traffic is concentrated in several large aviation hubs, while many regional airports remain underutilized despite their important socioeconomic role. The modernization of regional airports is necessary for improving territorial accessibility, increasing mobility of the population, and supporting economic development of remote regions. Expansion of domestic route networks, subsidization of socially important regional flights, and development of multimodal transport integration can significantly improve the efficiency of regional airport operations.

The development of transport-logistics functions of airports also represents a strategically important objective. Modern airports increasingly serve not only as passenger transportation facilities but also as key elements of international logistics chains. Kazakhstan's geographical position between Europe and Asia creates favorable conditions for the development of transit cargo transportation and air logistics hubs. The modernization of cargo terminals, implementation of digital customs clearance systems, and integration of airports into multimodal logistics corridors may significantly strengthen Kazakhstan's role within Eurasian transport networks.

Particular attention within the strategic framework should also be devoted to improving aviation safety and cybersecurity systems. The growing digitalization of airport operations increases dependence on information technologies and simultaneously raises the vulnerability of infrastructure to cyber threats and operational disruptions. Therefore, modernization programmes must include the implementation of advanced cybersecurity systems, intelligent surveillance technologies, automated emergency response systems, and integrated aviation safety monitoring platforms. Compliance with international aviation security standards will be a critical condition for maintaining international competitiveness and operational reliability.

Environmental sustainability constitutes another important strategic dimension of airport development. Global aviation trends increasingly emphasize the transition toward environmentally sustainable infrastructure solutions, including energy-efficient terminal buildings, renewable energy systems, waste management technologies, and reduction of greenhouse gas emissions. Kazakhstan's airport modernization strategy should therefore incorporate principles of green airport development aligned with international environmental standards and sustainable development goals. The implementation of environmentally friendly technologies will improve operational efficiency while enhancing the international image and investment attractiveness of Kazakhstan's aviation sector.

The development of human capital and professional competencies is equally important for the successful realization of modernization programmes. Advanced technological infrastructure requires highly qualified aviation specialists capable of operating digital systems, intelligent management platforms, and automated safety technologies. Consequently, strategic tasks should include modernization of aviation education systems, expansion of professional training programmes, international cooperation in personnel development, and strengthening of research and innovation capacity within the aviation sector.

Conclusion.

The conducted research demonstrated that the airport infrastructure system of the Republic of Kazakhstan occupies a strategically important position in ensuring national transport connectivity, economic growth, international integration, and regional development. Under conditions of increasing passenger mobility, globalization of transport flows, and intensifying competition among international transit corridors, the modernization of airport infrastructure becomes not only a sectoral task but also an essential element of the country's long-term socioeconomic and geopolitical strategy.

The analysis of the current state of Kazakhstan's airports confirmed that the national aviation sector has entered a stage of active transformation. Over the past decade, passenger traffic volumes have increased significantly, indicating a growing demand for air transportation services and the increasing importance of Kazakhstan as a transit territory between Europe and Asia. At the same time, the research established that the development of airport infrastructure remains highly uneven. The main concentration of passenger and cargo traffic is observed at the largest airports — Nursultan Nazarbayev (Astana), Almaty, and Shymkent — whereas a considerable number of regional airports continue to operate under conditions of insufficient technical modernization, limited investment support, and outdated operational infrastructure.

Particular attention in the study was devoted to the condition of regional airports, which play a critical role in ensuring territorial accessibility, regional mobility, and socioeconomic integration of remote regions. The obtained results demonstrate that many regional airports are characterized by significant physical deterioration of runways, obsolete airfield lighting and navigation systems, limited terminal capacity, and insufficient implementation of digital management technologies. Such limitations reduce operational efficiency, negatively affect flight safety indicators, and constrain the competitiveness of Kazakhstan's aviation sector in comparison with neighboring countries actively investing in airport modernization and technological innovation.

The comparative analysis with international airport systems in Turkey, the United Arab Emirates, and Singapore demonstrated that the effectiveness of airport infrastructure development depends not only on the physical condition of terminals and runways, but also on the quality of strategic management, the level of digitalization, operational flexibility, and the ability to attract private investment. International experience confirms that modern airports increasingly function as multifunctional transport-logistics, commercial, and technological hubs integrating passenger transportation, cargo logistics, digital services, tourism infrastructure, and smart management systems.

The research findings showed that Kazakhstan's airport sector continues to demonstrate a relatively high dependence on state financing, while the level of private investment participation remains limited. Although mechanisms of public-private partnership are gradually being introduced, their practical implementation remains constrained by insufficient transparency of concession procedures, regulatory uncertainties, and limited long-term guarantees for investors. Under such conditions, the development of an effective institutional environment for attracting domestic and foreign investment becomes one of the key priorities of state transport policy.

An important conclusion of the study is that the modernization of airport infrastructure should be considered not only as a technical reconstruction process, but also as a comprehensive transformation of management systems, operational technologies, and passenger service standards. The implementation of digital solutions — including automated passenger flow control systems, intelligent baggage handling systems, digital dispatch platforms, biometric identification technologies, and integrated airport management systems — represents a necessary condition for improving operational efficiency and compliance with ICAO and IATA international standards.

The conducted analysis additionally demonstrated that digitalization of airport management systems provides substantial operational and economic advantages. The integration of intelligent monitoring systems, predictive maintenance technologies, and automated operational control platforms allows airports to improve safety levels, optimize resource allocation, reduce operational delays, and enhance passenger service quality. In the long term, the introduction of artificial intelligence technologies, digital twins, and IoT-based infrastructure monitoring systems may become a decisive factor in the formation of "smart airports" operating within the principles of Industry 4.0 and sustainable transport development.

The research also confirmed that the sustainable development of Kazakhstan's airport network is impossible without balanced territorial planning. Excessive concentration of passenger flows in several major aviation hubs increases infrastructural pressure and limits the development potential of regional transport systems. Therefore, one of the strategic priorities should be the modernization of regional airports and the expansion of domestic air transportation networks connecting remote territories with the country's major economic centers. Such measures will contribute not only to increased mobility of the population but also to tourism development, investment attraction, labor market expansion, and strengthening of interregional economic integration.

From the perspective of transport logistics, Kazakhstan possesses significant potential for becoming a major Eurasian aviation hub due to its favorable geographical location between Europe and Asia. However, realization of this potential requires accelerated modernization of airport infrastructure, improvement of multimodal transport integration, and enhancement of service quality to international standards. Airports must increasingly function as elements of integrated transport-logistics ecosystems combining air, rail, and road transport infrastructure within unified digital management environments.

REFERENCES

- Abdrakhmanova, 2022 – Abdrakhmanova, A. (2022). Razvitie transportnoi infrastruktury Kazakhstana: analiticheskii obzor [Development of transport infrastructure of Kazakhstan: an analytical review]. Almaty: Ekonomika. 50 p. [In Russ.]
- Afonin, 2014 – Afonin, A.M., et al. (2014). Transportnaia logistika: organizatsiia perevozki gruzov [Transport logistics: organization of freight transportation]. Moscow: Forum: INFRA-M. 180 p. [In Russ.]
- Aspanova, 2025 – Aspanova, A. (2025). Gosudarstvenno-chastnoe partnerstvo v modernizatsii aeroportovoi infrastruktury Kazakhstana [Public-private partnership in the modernization of airport infrastructure of Kazakhstan]. Almaty: Transport i logistika. 420 p. [In Russ.]
- Bazaeva, 2014 – Bazaeva, B. (2014). Perevozka gruzov vozdushnym transportom [Air freight transportation]. Aviatsonnaia shkola Aeroflota. 210 p. [In Russ.]
- Doganis, 2019 – Doganis, R. (2019). The Airline Business. 4th ed. London: Routledge. 320 p. [In Eng.]
- Graham, 2014 – Graham, A. (2014). Managing Airports: An International Perspective. 4th ed. London: Routledge. 350 p. [In Eng.]
- ICAO, 2007 – ICAO. (2007). Prognoz razvitiia vozdushnogo transporta do 2025 goda [Air transport development forecast to 2025]. 65 p. [In Russ.]
- ICAO, 2020 – ICAO. (2020). Rukovodstvo po ekonomicheskim i finansovym meram po umensheniiu vliianiia vspyshki koronavirusa na aviatsiiu [Guidance on economic and financial measures to reduce the impact of the coronavirus outbreak on aviation]. Available at: <https://www.icao.int>. Accessed: 18.01.2025. [In Russ.]
- ICAO, 2021 – ICAO. (2021). Rukovodstvo po standartam i praktike upravleniia aeroportami [Manual on standards and practices for airport management]. 60 p. Available at: <https://www.icao.int>. Accessed: 19.01.2025. [In Russ.]
- Kasymbekova et al., 2019 – Kasymbekova, A., et al. (2019). Razvitie transportnoi infrastruktury Kazakhstana: opyt i perspektivy [Development of transport infrastructure of Kazakhstan: experience and prospects]. Almaty: Transport. 150 p. [In Russ.]
- Kazakhstan-2050 Strategy, 2012 – Novyi politicheskii kurs sostoavshegosia gosudarstva: Poslanie Prezidenta RK N.A. Nazarbaeva narodu Kazakhstana, Astana, 14 dekabria 2012 g. [New political course of an established state: Address of the President of the Republic of Kazakhstan N.A. Nazarbayev to the people of Kazakhstan]. Available at: <https://adilet.zan.kz/rus>. Accessed: 18.01.2025. [In Russ.]
- Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan, 2024 – Statisticheskii otchet o razvitiu aviatsionnoi otrasli Kazakhstana [Statistical report on the development of the aviation sector of Kazakhstan]. Astana: MIIR RK, 2024. 60 p. Available at: <http://www.miit.gov.kz>. Accessed: 18.01.2025. [In Russ.]
- Miroshnikova, 1983 – Miroshnikova, A.V. (ed.). (1983). Ekonomika, organizatsiia i planirovanie grazhdanskoi aviatsii [Economics, organization and planning of civil aviation]. Moscow: Transport. 240 p. [In Russ.]
- Nurpeisov, 2020 – Nurpeisov, A. (2020). Infrastrukturnye problemy regionalnykh aeroportov Kazakhstana [Infrastructure problems of regional airports of Kazakhstan]. Almaty: Academy of Civil Aviation. 70 p. [In Russ.]
- On Approval of the National Project "Strong Regions — Driver of Country Development", 2021 – Decree of the Government of the Republic of Kazakhstan No. 729 of 12 October 2021. Available at: <https://adilet.zan.kz/rus/docs/P2100000729/history>. Accessed: 16.01.2025. [In Russ.]
- On Approval of the State Infrastructure Development Programme "Nurly Zhol", 2019 – Decree of the Government of the Republic of Kazakhstan No. 1055 of 31 December 2019. Available at: <http://adilet.zan.kz/rus/docs/P1900001055>. Accessed: 17.01.2025. [In Russ.]
- Ratushna, 2011 – Ratushna, A. (2011). Formirovanie mekhanizma upravleniia neaviatsionnoi deiatel'nost'iu aeroporta [Formation of a mechanism for managing the non-aviation activities of an airport]. Available at: http://www.nbu.gov.ua/ejournals/PSPE/2011_4/Ratushna_411.html. Accessed: 18.01.2025. [In Russ.]