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GREEN TRANSPORT CORRIDORS AS A FACTOR OF SUSTAINABLE COMPETITIVE ADVANTAGES OF KAZAKHSTAN IN CENTRAL ASIA

Abstract

The article provides an empirical and analytical assessment of Kazakhstan's ability to transform its existing transport and logistics infrastructure into a competitive advantage within Central Asia. Based on a comparison of indicators for 2020–2024 and a case-study analysis, the authors demonstrate the country's substantial infrastructural capacity-including an extensive railway network, port connectivity through the Caspian Sea, and key border crossings with China-which has supported a notable increase in transit volumes. The analysis of technological and institutional developments highlights progress in the digitalization of operations (electronic documentation and tracking platforms), partial railway electrification, and the expansion of renewable-energy initiatives. The authors show that the combination of digital traceability and technical modernization creates the foundations for the commercialization of low-carbon transport corridors; at the same time, several constraints are identified, including uneven electrification, the need for accurate verification of energy consumption and the share of renewables, as well as fragmented regional digital integration, which collectively limit the full realization of this potential. The results have practical significance for policy formation and investment strategies in the field of transit logistics.

Keywords: green logistics, transport decarbonization, institutional reforms, digitalization, competitive advantages, climate finance, sustainable development.

Introduction

In recent years, the global reorganization of supply chains and stricter climate regulations have fundamentally altered the competitiveness of transit economies. Transit is no longer simply a geographical attribute: it is becoming a manageable product, the value of which is determined not only by the speed and cost of transportation, but also by predictability, the level of digitalization, and the carbon profile [1]. For Central Asian countries, historically focused on the transfer of cargo

flows between China and Europe, these transformations carry both risks in the form of the loss of some traditional routes with the emergence of new commercially and environmentally preferable alternatives, and opportunities in the form of the formation of "green" and digital corridors as a new source of competitive advantage.

Kazakhstan is a special case study in this context. Its transport infrastructure combines a large, extensive railway network (approximately 16,000 km) with port infrastructure on the Caspian Sea and two strategic border crossings with China (Dostyk and Khorgos). Based on a combination of indicators, the republic is assigned a significant share of regional transit: according to estimates, Kazakhstan's share in land transit between China and Europe is estimated to be in the range of 60–70%, and the volume of transportation within the country increased from approximately 11.6 million tons in 2020 to approximately 21.3 million tons in 2024 [2]. These quantitative characteristics indicate that Kazakhstan has not only a geographical advantage, but also a real infrastructure and operational reserve that allows it to claim the role of a regional logistics hub. At the same time, a significant portion of this potential is realized through institutional mechanisms (membership in the EAEU, electronic customs procedures) and digital initiatives, which emphasizes the dependence of competitiveness on the quality of management and coordination.

Along with the change in demand for transit services, the regulatory environment for foreign trade is also changing. The introduction of European carbon regulation instruments, primarily CBAM (Carbon Border Adjustment Mechanism), shifts the competitive focus to the overall carbon footprint of supply; for energy-intensive sectors, this means logistics has a significant impact on production costs and, consequently, on route selection. Under this new logic, corridors with a high share of electric traction and the ability to use renewable energy gain a commercial advantage, while digital systems capable of verifiable emissions accounting and optimizing operational parameters become a factor in transforming technical capabilities into a tradable service.

Despite the active literature on modal shift and digitalization of logistics, applied research on Central Asia has not yet consistently linked three levels of analysis: (a) the macrostructural resource base (geography, ports, route length), (b) technological transformations (electrification, renewable energy, digital platforms), and (c) institutional mechanisms for the commercialization of "green" corridors (certification, tariff harmonization, climate finance). This study aims to fill this gap by systematically assessing the potential of green logistics as a driver of sustainable competitive advantages for Kazakhstan compared to its Central Asian neighbors and identifying the mechanisms through which decarbonization and digitalization can strengthen and commercialize existing infrastructural advantages. To achieve this goal, we synthesize theoretical approaches, analyze available statistical indicators and case initiatives, and formulate practical recommendations aligned with current infrastructure projects and international regulatory trends.

Materials and methods

The study is qualitative and analytical in nature and is based on a mixed methodology aimed at drawing practically and politically relevant conclusions with limited comparability of primary statistical data for the region. The methodological objective was to comprehensively assess how the combination of geographic, infrastructural, and institutional factors shapes Kazakhstan's logistical advantage and the mechanisms through which decarbonization, and digitalization processes can enhance and commercialize this advantage.

The empirical base consisted of three groups of materials: 1) official strategic documents of the Republic of Kazakhstan in the areas of transport, energy and environmental policy; 2) analytical reports of international financial institutions and specialized organizations (EBRD (European Bank for Reconstruction and Development), World Bank, ADB (Asian Development Bank), TRACECA and Middle Corridor studies); 3) technical descriptions and reports on digitalization and greening pilot projects, including electronic declaration and traceability projects (e-customs, SmartCargo, Keden) and materials on the electrification of railway sections. An additional body of sources was compiled from applied and academic literature on carbon accounting and sustainable logistics methodologies [3, 4]. All sources were selected based on their relevance to the study objectives, timeliness (typically within the last 10 years), and authoritativeness.

The analytical framework of the study combines three complementary approaches: resource-based view (RBV), dynamic capabilities theory (DC), and an institutional approach. The RBV is used to identify and describe unique and difficult-to-replicate resources – geographic location, configuration and length of the railway network, port infrastructure and actual transit volumes. Dynamic capabilities theory is used to analyze the adaptive potential of public institutions and operators – their ability to transform these resources through investment, modernization, and the implementation of digital platforms and energy technologies. The institutional approach allows to assess the degree of tariff and procedural alignment, the presence of emissions verification mechanisms, and the availability of green financing – factors that determine the conditions for the commercialization of low-carbon transport corridors.

Results and discussion

Kazakhstan is located on a key land axis between East Asia and Europe, making it a natural transit "bridge" for Eurasian transport [5]. According to some estimates, Kazakhstan accounts for approximately 70% of land transit between China and Europe; this proportion is not accidental, but stems from its geographic location, the presence of border crossings on the Chinese border, and its role as a link in the Middle Corridor routes [6]. The geographical factor serves as the foundation on which institutional and infrastructural advantages are superimposed: membership in the EAEU ensures the harmonization of tariffs and customs procedures, while access to the Caspian Sea and developed port capacities create the possibility of forming full-fledged multimodal chains (railway – sea passage – further delivery through the Caucasus and further to Europe).

As shown in figure 1, the distribution of total transit shares across Central Asian countries for 2024 confirms the described structural asymmetry: Kazakhstan – 49%, Uzbekistan – 31.5%, Turkmenistan – 13%, Kyrgyzstan – 5%, Tajikistan – 1.5% [7].

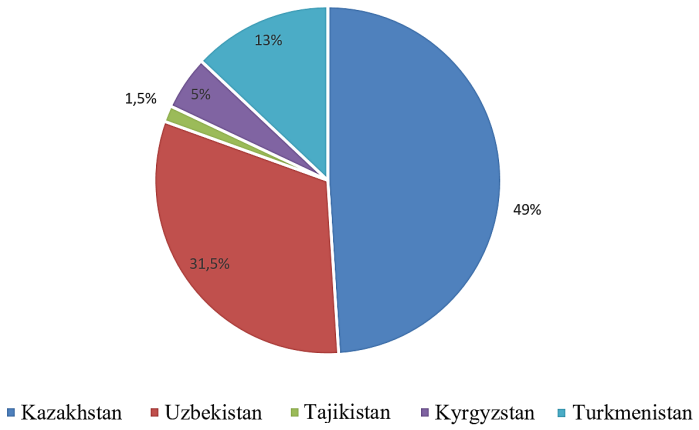

Figure 1 – Share of Central Asian countries in transit traffic in 2024

Note: Compiled by the authors based on the [7].

The data in Figure 1 and, subsequently, figure 2, refer to 2024, as this is the latest completed annual period for which comparable figures are available. The source [7] was published for 2025, but the calculations presented in this article do not reflect the full year 2025.

Figure 1 shows that transregional flows are concentrated around Kazakhstan's transit infrastructure, while Uzbekistan is only the second most important node, and the other countries occupy minor positions.

According to the Logistics Performance Index (LPI), Kazakhstan has a score of approximately 2.7 (79th globally), Uzbekistan – 2.6 (88th globally), Tajikistan – 2.5 (124th globally), Kyrgyzstan – 2.3 (128th globally), while Turkmenistan is not represented in the latest LPI releases [8, 9]. The LPI gap reflects differences not only in "hard" infrastructure but also in the quality of customs procedures, digital integration, cargo tracking capabilities, and on-time delivery. Even Kazakhstan's slight advantage in

the LPI correlates with real operational advantages: shorter transit times, more predictable end-to-end processes, and better multimodal handling capabilities.

Taken together, the presented indicators – market shares, volume time series, and LPI indices – indicate that Kazakhstan has comprehensive prerequisites for a competitive advantage. This advantage is based on a combination of geography, developed and expanding infrastructure (including ports and railways), institutional integration, and the quality of logistics services. In practical terms, this means that Kazakhstan not only maintains a leading position in current flows but also has high potential to further strengthen its status as a transit hub, including in segments focused on sustainable and certified "green" routes.

Kazakhstan has the longest and most operationally significant railway network in Central Asia – approximately 16,000 km – which provides the technical basis for more energy-efficient and high-speed transportation [10]. With this infrastructure in place, major capacity-enhancing projects are underway: doubling the Dostyk – Moiynty section (836 km) increases the line's capacity from approximately 12 to 60 pairs of trains per day and significantly reduces transit times for container trains, while the construction of a double-track Bakhty –Ayagoz line (272 km) is expected to increase mutual capacity with China from an estimated 28 million tons to approximately 48 million tons per year by 2027 [11]. Along with the modernization of the railway infrastructure, the port infrastructure is being steadily expanded: Aktau and Kuryk are expanding their handling capacities; the container hub project in Aktau is planned to reach an annual capacity of approximately 200,000–240,000 TEUs, while Kuryk handled approximately 1.96 million tons in 2024 and commissioned a large grain terminal, strengthening the connection of agricultural exports with the Trans–Caspian Corridor [12].

Uzbekistan is a regional giant in terms of the length of its railway network (approximately 7,400 km) and has a relative advantage in terms of electrification (approximately 2,500 km, i.e. ≈34%), is developing a network of dry ports (24 facilities with international status) and is introducing high-speed passenger routes, which strengthens internal connectivity [13]. However, the lack of direct access to the sea limits multimodal options, while the network's geographic fragmentation and historical political barriers hinder Uzbekistan's development into a fully-fledged China–Europe corridor: dry ports collectively handle approximately 100,000 TEUs, significantly less than the container capacity of Kazakhstan's ports [14]. As a result, Uzbekistan remains a strong regional hub, but its complementarity is viewed more as a complement to the Kazakhstan corridor than as a competing alternative.

Kyrgyzstan is characterized by critically limited railway infrastructure (approximately 424.6 km, divided into unconnected sections) and a complete lack of electrification; mountainous topography creates high costs and long transit times [15]. The China–Kyrgyzstan–Uzbekistan (CKU) project offers the prospect of a new route, but it is initially planned with diesel traction and limited capacity; even after completion, it is premature to expect Kyrgyzstan to quickly become a competitive corridor, as years of investment and technical reorganization are required to overcome natural and geographical limitations.

Tajikistan has a minimal and geographically dispersed railway network (approximately 680–997 km) without electrification; systemic disruptions and fragmentation, including due to historical section closures, significantly limit its role in transit. Tajikistan is potentially important for southern routes, but it relies heavily on the infrastructure of its neighbors to access foreign markets; financial and institutional constraints prevent the country from rapidly expanding its transit role.

Turkmenistan has a comparatively long route network (estimated at 4,98–6,56 km) and access to the Caspian Sea via the port of Turkmenbashi. However, the lack of electrification, low operating speeds (estimated at 32–45 km/h), and limited container throughput (estimated at 50,000–100,000 TEU) reduce its competitiveness for transcontinental shipping [16]. Turkmenistan is more focused on southern and Caspian routes; without significant digital and institutional integration, its ability to remain a comparable corridor is limited.

The Logistics Performance Index reflects differences in infrastructure, customs procedures, traceability, and on-time delivery: Kazakhstan maintains an advantage over its neighbors both in absolute network and port indicators and in the operational maturity of digital and institutional mechanisms (particularly e-customs and single-window systems). These differences are not limited to "hard" assets: the comprehensive picture includes network effects and institutional predictability, making competitive advantage replicable over time. Investments in railway modernization and port

infrastructure create a multiplier effect: increased throughput attracts operators and cargo, which increases the profitability of terminal investments and enhances economies of scale.

An analysis of the dynamics of annual transit volumes (see fig. 2) provides additional empirical evidence to support this conclusion. According to annual data, volumes for Kazakhstan increased from 11.6 million tonnes in 2020 to 21.3 million tonnes in 2024; overall, regional volumes increased from 22 million tonnes to 39.3 million tonnes over the same period. Uzbekistan demonstrated growth from 8 to 12 million tonnes, Turkmenistan from 1 to 5 million tonnes, while Kyrgyzstan and Tajikistan maintained minimal values (approximately 0.8-1.0 and 0.2–0.3 million tonnes, respectively). Figure 2 clearly demonstrates that the absolute and relative contribution to regional growth was primarily provided by Kazakhstan: it accounted for the majority of the increase in freight traffic, both in absolute figures and in relative rates.

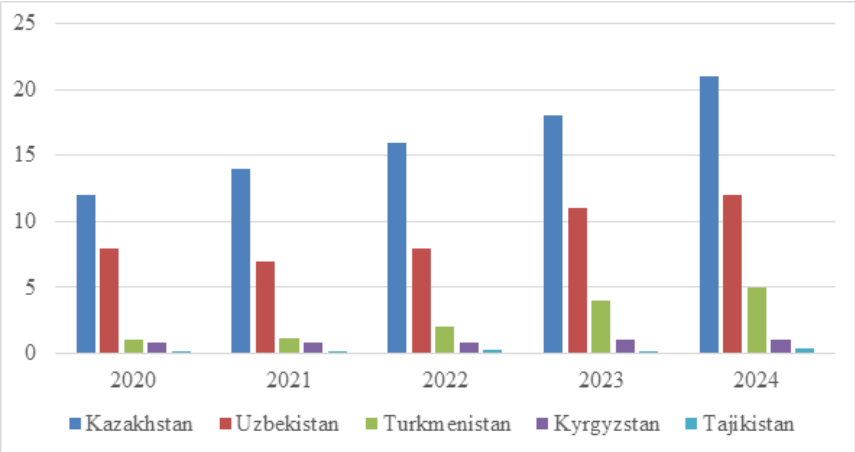

Figure 2 – Annual transit volumes, million tons

Note: Compiled by the authors based on the [7].

Ultimately, the regional profiles demonstrate that Kazakhstan is developing a multifaceted competitive position: geographic location and network scale provide a head start; electrification and large-scale projects eliminate operational bottlenecks; ports and multimodal integration expand the range of commercially available options; and digitalization and organized multimodal operators ensure predictability and manageability.

Infrastructure reserves alone rarely provide a sustainable commercial advantage: the ability to transform technical assets into a manageable, verifiable, and marketable product is crucial. Operational digitalization and institutional alignment are key mechanisms for this transition. The implementation of electronic customs procedures, single-window platforms, and localized intelligent solutions reduces transaction costs, shortens border clearance times, and increases supply chain predictability [1], transforming infrastructure into a valuable service with minimal downtime – a factor often more important than direct transportation costs for large cargo owners. Kazakhstan's membership in the EAEU further reduces regulatory and tariff uncertainty on routes to Russia and Belarus, which reduces transaction risks and enhances the competitive advantages of routes through the country.

Growing volumes and high terminal throughput create significant network effects: scale increases the efficiency of terminal equipment, reduces unit costs, and stimulates the influx of operators and investment in digital platforms, which in turn increases the speed and transparency of operations. In this environment, projects like CKU, North-South, and Uzbekistan's dry ports often complement rather than replace Kazakhstan's corridors, redirecting some flows and strengthening regional connectivity.

The full potential of corridors can only be realized through a combination of decarbonization and digitalization [17]. Grid electrification and increasing the share of renewable energy sources are not only environmental goals but also systemic drivers of competitiveness: an electrified grid is a rare and difficult-to-reproduce resource [18], and the ability of operators and institutions to adapt and reconfigure infrastructure determines its strategic sustainability [19]. In Kazakhstan, approximately 4,200–4,300 km of the approximately 16,000 km grid have been electrified, which already significantly

reduces energy consumption and the carbon intensity of transportation [20]. As the share of renewable energy sources in generation increases, the decarbonization effect intensifies [21].

Economic benefits manifest themselves in reduced operating costs and latent risks associated with carbon regulation. On a typical Shanghai–Europe route, electric traction reduces energy consumption compared to diesel, and with the implementation of CBAM, low-carbon routes may gain a relative cost advantage due to reduced adjustment payments [22].

The digital commercialization mechanism transforms the described technological and economic effects into a measurable market product. Modern IT solutions – the SmartCargo platform, the Keden and Tez Customs systems, and local startups developed within the Astana Hub – enable near-real-time carbon footprint verification, optimized rolling stock loading and delivery routes, and reduced idle runs and downtime at border crossings. Digitalization provides the practical ability to calculate and document Scope 1, 2, and 3 indicators in accordance with international standards such as the GLEC Framework and ISO 14083 [23, 4]. Without such verification, a low-carbon route remains merely a technical possibility; with the introduction of digital tools, it becomes a selling point that allows operators to position themselves as providers of ESG-compliant solutions and gains recognition from large corporate cargo owners, such as global retailers, electronics manufacturers, and automakers seeking to minimize the carbon footprint of their supply chains [24].

Institutional and financial effects complete this three-tiered system of enhancing competitive advantages. The ability to provide a low-carbon route certified to international standards opens access to targeted climate finance: loans at reduced rates, "green bonds," and grants from multilateral financial institutions (World Bank, EBRD, and the Asian Development Bank), which, given the high cost of capital in transition economies, become a significant competitive advantage. Moreover, certification creates positive network effects: increased low-carbon transit volumes attract additional investment in expanding electrified sections and modernizing port facilities, reducing unit costs and further strengthening Kazakhstan's position as a provider of sustainable transport solutions [25]. Furthermore, compliance with global ESG and climate responsibility standards increases the trust of international partners and reduces transaction costs when interacting with Western companies and investors, who are increasingly integrating climate criteria into their supplier and route selection processes.

At the same time, existing limitations require critical analysis. Firstly, the electrification process is uneven: only 26–27% of the network is electrified, and the rate of expansion of electric sections depends on funding, which remains unstable. Furthermore, the actual energy consumption of individual locomotives and the relationship between the target share of renewable energy sources and the actual rate of their implementation require more detailed verification on an annual basis. Secondly, digital platforms, although demonstrating encouraging results in pilot sections (reducing processing time by 20–30%), have not yet achieved full interoperability between countries – problems with data synchronization on the Uzbek and Turkmen sections of the routes remain, which reduces the end-to-end efficiency of the corridor (an in-depth study of the degree of platform integration and losses from incompatibility is required). Third, the details of CBAM implementation remain uncertain regarding the precise rates of adjustment charges and the mechanisms for recognising non-tariff emission reduction measures, which complicates long-term investment planning (requiring constant monitoring of updates to European regulations).

Monitoring and further development of analytics should focus on several priority areas. It is necessary to expand data collection on actual locomotive energy consumption and fill the gap in statistics on the distribution of freight flows by traction type (diesel, electric, alternative fuels) on an annual and quarterly basis; this will allow us to clarify the real economic and environmental impacts of electrification. A systematic analysis of the impact of digitalization of customs procedures on border crossing times and freight volumes is also required, highlighting the effects that can be attributed specifically to digital tools, as opposed to other management improvements. Finally, it is necessary to develop a model to assess the impact of CBAM expansion on the distribution of transit flows between routes and forecast the shift from high-emission to low-carbon corridors, considering the dependence of route choice on the cost of carbon offsets and competition among alternative routes.

To summarize the identified strengths and weaknesses of Kazakhstan's transport and logistics system and systematize the factors influencing the development of "green" competitive advantages at the regional level, it seems appropriate to conduct a SWOT analysis. A SWOT analysis serves as a

transition link between the empirical part of the study and the conceptual model (figure 3), allowing for a logical transition to an explanation of the mechanisms underlying competitive advantage.

Table 1 – SWOT analysis of Kazakhstan's competitiveness in "green" transport corridors

Strengths (S)	Weaknesses (W)
• 16,000 km of railway network • Two key border crossings with China (Dostyk and Khorgos) • Access to the sea (the Caspian Sea) • Strong pace of digitalisation • Port infrastructure • High capacity on modernised sections	• 26–27% electrification, which is low relative to stated ambitions • Fragmented integration with neighbouring countries • Insufficient share of renewable energy sources • High capital intensity of projects
Opportunities (O)	Threats (T)
• Growing demand for low-carbon routes in the EU and China • CBAM creating a "green premium" • Climate financing (EBRD, ADB, World Bank) • Strengthening of the Middle Corridor • Growth in renewable energy exports	• Competition from alternative routes (Northern Corridor, CKU, NS) • Uncertainty regarding CBAM rules • Instability of regional coordination • Risks of delays in infrastructure projects
Note: Compiled by the authors.	

To systematize the identified relationships and summarize the key findings of this study, it seems appropriate to combine infrastructural, technological, and institutional factors into a single logical framework. The proposed model (see figure 3) reflects a sequential transition from basic resources and geographic parameters to mechanisms for their technological rethinking, digital verification, and market commercialization, demonstrating how the combination of these elements creates a reproducible competitive advantage for Kazakhstan in the green transport corridor segment. This diagram allows for the visualization of cause-and-effect relationships and serves as a conceptual basis for the further development of practical measures and strategic decisions.

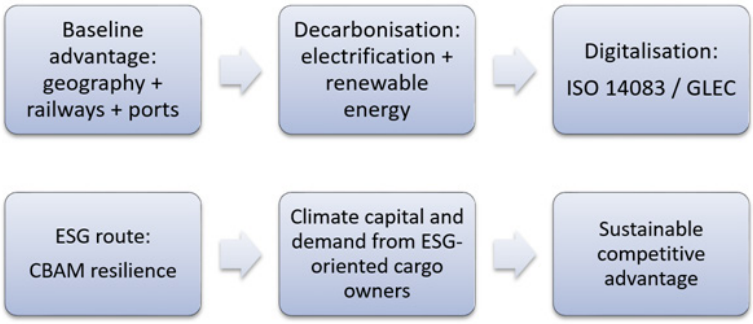

Figure 3 – Mechanism for shaping the competitive advantage of Kazakhstan's "green" transport corridors

Note: Compiled by the authors.

The presented conceptual model describes the causal chain through which Kazakhstan transforms its infrastructure advantage into a long-term, replicable competitive advantage in the transit and logistics services market. The logic of the model integrates resource-based theory, dynamic capabilities theory, and an institutional approach, allowing us to trace the transition from tangible assets to market rents through technological, organizational, and regulatory mechanisms.

The first level comprises a set of geographic and infrastructural characteristics, which, in terms of resource-based theory, are described as valuable, rare, difficult to imitate, and irreplaceable. Key elements include Kazakhstan's transit location between East Asia and Europe, an extensive railway network, two direct border crossings with China, and port infrastructure on the Caspian Sea. These

parameters create a starting logistical advantage, positioning the country as a natural transit hub for Eurasian flows.

However, the historical experience of other transport hubs demonstrates that geography and infrastructure alone do not guarantee sustainable competitive positions. Changes in technological standards and regulatory regimes can devalue previous advantages if not accompanied by adaptation. Therefore, the infrastructure base in the model is viewed as a starting platform requiring further transformation.

The second level reflects the technological rethinking of existing infrastructure through decarbonization. It focuses on two interrelated areas: electrification of the rail network and the expansion of renewable energy sources.

Electrification of rail transport reduces energy consumption and operating costs compared to diesel traction, shortens travel times, and improves the carbon profile of transportation. As a result, the same infrastructure circuit begins to provide higher energy efficiency and lower emissions per tonne-kilometer. The parallel increase in the capacity of renewable energy facilities and their share in the generation mix leads to a reduction in the carbon intensity of electricity consumption. With an increase in the share of "green" generation, electric traction automatically becomes less emissions-intensive without the need for radical modernization of rolling stock.

This combination of electrification and renewable energy expansion, within the logic of dynamic capability theory, is interpreted as the system's ability to reconfigure existing resources in response to changing external demands. Infrastructure remains the same in form, but its content changes: its use becomes more consistent with the requirements of a low-carbon economy and climate regulation.

The third level describes the transition from technological improvement to market monetization. Even with significant emissions reductions, a low-carbon pathway remains merely a "technical fact" unless its parameters can be measured, documented, and recognized by external stakeholders. This function is performed by digital platforms that enable the calculation and monitoring of emissions in accordance with international standards.

Integrated information systems and specialized solutions enable the accounting of direct and indirect emissions across the entire supply chain and the creation of a verifiable carbon profile for the route. This enables the certification of corridors as ESG-compliant. For large multinational companies integrating climate indicators into their strategies, having a transparent, certified low-carbon route becomes a distinct logistical advantage. The technological result of decarbonization gains market value: it becomes a marketable service with verifiable characteristics.

The fourth level captures how the decarbonization-digitalization nexus translates into concrete economic outcomes. First, low-carbon routes help reduce the costs associated with climate regulation, including risks arising from cross-border carbon adjustment mechanisms. This reduces the entry costs of products into sensitive markets and increases the resilience of export chains.

Secondly, demonstrating compliance with international climate and ESG standards expands access to targeted financing instruments: concessional loans, green bonds, and grant programs. Lower capital costs make investments in further infrastructure and energy modernization more attractive, improving their return on investment.

Thirdly, positioning the route as low-carbon and digitally transparent allows it to target cargo owners willing to pay a premium for a reduced carbon footprint and mitigated regulatory risks. Increased demand from such clients increases corridor utilization and the margins of logistics services.

The fifth level of the model describes the formation of positive feedback loops that transform isolated improvements into a sustainable system of benefits. Increased traffic volumes along modernized corridors enhance economies of scale: infrastructure utilization increases, unit costs decrease, and incentives for new investments in electrification, terminals, and digital services are created. This, in turn, further enhances the attractiveness of the routes for cargo owners and investors.

At the same time, a stable institutional framework is being formed: verification procedures are being standardized, digital solutions are being unified, and practices for using climate finance are being consolidated. New participants are easing entry into the system, and accumulated experience reduces transaction costs for coordination. Over time, a reputational effect is added: a successful history of operating "green" corridors strengthens the trust of partners and investors, creating additional trust rent. The model thus demonstrates not simply a list of measures, but an internal logic through which

technological, institutional, and market mechanisms mutually reinforce each other, turning "green" logistics into a competitive advantage for Kazakhstan.

Conclusion

The study provided a comprehensive assessment of how Kazakhstan can transform its existing transport and logistics potential into a sustainable competitive advantage amid the global transition to low-carbon supply chains. The findings demonstrate that the country's infrastructure base – an extensive railway network, two border crossings with China, access to the sea via the Caspian Sea, and the expanding capacity of the Aktau and Kuryk ports – forms a structural foundation upon which technological and institutional mechanisms for developing "green" corridors can be built.

The key conclusion of the study is that the competitiveness of Kazakhstan's logistics corridors in the coming years will be determined not only by infrastructure but also by the ability to convert it to a low-carbon and digitally verifiable form. The analysis showed that electrification of the railway network and increasing the share of renewable energy are two complementary mechanisms that create the preconditions for reducing the energy and carbon intensity of transit. The parallel development of digital platforms that enable emissions monitoring and calculation according to international standards (GLEC, ISO 14083) transforms technological improvements into a tradable logistics product – a certifiable "green" route. This combination reduces the regulatory risks associated with CBAM, increases the attractiveness of corridors for ESG-conscious cargo owners, and provides access to climate finance, thereby enhancing the economic sustainability of modernization projects.

At the same time, the study identified a number of constraints hindering the potential for developing "green" corridors: low grid electrification, an insufficient share of renewable energy in generation, fragmented digital interoperability with neighboring countries, and the lack of unified mechanisms for international verification of the carbon profile of routes. These factors require a systemic solution and could limit Kazakhstan's ability to consolidate its leadership against competing initiatives – the CKU, the North-South Corridor, and the strengthening of land-based alternatives.

Based on the analysis, the following strategic development areas can be formulated: accelerating the electrification of key transit sections; developing "green" energy services for rail transport; aligning digital metering and control systems with international standards; creating a national and regional mechanism for recognizing low-carbon routes; and institutionally harmonizing procedures with Uzbekistan, Kyrgyzstan, and Turkmenistan. Implementing these areas will not only strengthen Kazakhstan's current advantage but also position it among international leaders in the development of sustainable transport corridors.

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ЖАСЫЛ КӨЛІК ДӘЛІЗДЕРІНІҢ ҚАЗАҚСТАННЫҢ ОРТАЛЫҚ АЗИЯДАҒЫ ТҰРАҚТЫ БӘСЕКЕЛІК АРТЫҚШЫЛЫҚТАРЫН ҚАЛЫПТАСТЫРУДАҒЫ РӨЛІ

Аңдатпа

Мақалада Қазақстанның қолда бар көлік-логистикалық инфрақұрылымын Орталық Азия аймағында бәсекелік артықшылық көзіне айналдыру әлеуетіне эмпирикалық-талдамалық бағалау ұсынылады. 2020–2024 жж. көрсеткіштерін салыстыру және кейс-талдау нәтижелері еліміздің инфрақұрылымдық қорының айтарлықтай жоғары екенін – теміржол желісінің кеңдігі, Каспий арқылы порттық байланыс, Қытаймен

негізгі шекаралық өткелдердің болуы – және олардың транзит көлемдерінің едәуір өсуіне ықпал етіп отырғанын көрсетеді. Технологиялық және институционалдық өзгерістерді талдау операцияларды цифрландырудың (электрондық рәсімдеу және трекинг платформалары), теміржолдың белгілі бір бөлігінің электрлендірілуінің және жаңартылатын энергия бастамаларының кеңеюінің ілгерілеп жатқанын айқындайды. Авторлар цифрлық қадағалану мен техникалық жаңғыртудың үйлесуі төмен көміртекті маршруттарды коммерцияландыруға негіз қалдыратынын атап өтеді; сонымен қатар электрлендірудің біркелкі еместігі, энергия тұтынуы мен ЖЭК үлесін дәл верификациялау қажеттілігі және өңірлік цифрлық интеграцияның фрагментациясы сияқты толық әлеуеттің іске асуын шектейтін кедергілер белгіленеді. Зерттеу нәтижелері транзиттік логистика саласындағы саясат қалыптастыру мен инвестициялық стратегияларды әзірлеу үшін практикалық мәнге ие.

Тірек сөздер: экономика, стратегиясы, практикасы жасыл логистика, институционалдық реформалар, цифрландыру, бәсекелестік артықшылықтар, климаттық қаржыландыру, орнықты даму.

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ЗЕЛЕНЫЕ ТРАНСПОРТНЫЕ КОРИДОРЫ КАК ФАКТОР УСТОЙЧИВЫХ КОНКУРЕНТНЫХ ПРЕИМУЩЕСТВ КАЗАХСТАНА В ЦЕНТРАЛЬНОЙ АЗИИ

Аннотация

Статья предоставляет эмпирико-аналитическую оценку способности Казахстана трансформировать имеющуюся транспортно-логистическую инфраструктуру в конкурентное преимущество в регионе Центральной Азии. На основе сопоставления показателей 2020–2024 гг. и кейс-анализа авторы демонстрируют значительный инфраструктурный запас страны – развитую сеть железных дорог, портовую связанность через Каспий и ключевые погранпереходы с Китаем, что сопутствует заметному росту транзитных объемов. Анализ технологических и институциональных изменений фиксирует прогресс по цифровизации операций (платформы электронного оформления и трекинга) и частичную электрификацию дороги, а также нарастание ВИЭ-инициатив. Авторы показывают, что сочетание цифровой прослеживаемости и технической модернизации создает предпосылки для коммерциализации низкоуглеродных маршрутов; одновременно выделены барьеры – неравномерность электрификации, необходимость точной верификации энергопотребления и доли ВИЭ, а также фрагментарность региональной цифровой интеграции – которые ограничивают полную реализацию потенциала. Результаты имеют практическую значимость для формулирования политики и инвестиционных стратегий в сфере транзитной логистики.

Ключевые слова: зеленая логистика, институциональные реформы, цифровизация, конкурентные преимущества, климатическое финансирование, устойчивое развитие.

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