SATBAYEV UNIVERSITY

Journal of Energy, Mechanical Engineering and Transport

Volume 2 (2025), Issue 1, 31-36

https://doi.org/10.51301/jemet.2025.i1.06

Analysis of transit potential factors of the republic of Kazakhstan along the Trans-Caspian transport route

Z.M. Tymbayeva, N.Z. Tolkynbek*, D.N. Seilkhan

Satbayev University, Almaty, Kazakhstan

**Corresponding author: n.tolkynbek@satbayev.university*

Abstract. This article explores the factors that have a significant impact on the development of transit traffic along the Trans-Caspian transport route. Currently, the Republic of Kazakhstan is becoming one of the determining factors in the development of transport routes within the Eurasian space at the junction between China and Europe. Latitudinal and meridional international transport corridors (ITC) - routes in the direction «East-West» and «North-South» - run along the EAEU territory. The geography of the region allows for the delivery of goods both exclusively by land and multimodal, combining different modes of transport. The study was conducted using correlation and regression analysis based on data from open sources. The results obtained allowed to identify the most significant factors, the development of which will create conditions for the development of transit transportations in Kazakhstan.

Keywords: *transport route, institutional element, public element, scientific component, international freight transport, costs.*

1. Introduction

In recent years, the importance of transit potential for the Republic of Kazakhstan has been growing, which allows increasing its significance in the development of the national economy [1]. Trans-Caspian transport route is an international transport corridor China - Turkey - Europe. It is intended to provide a transport link between China and Europe bypassing Russia, through Kazakhstan, Azerbaijan, Georgia and Turkey [2]. Since the etiology of transit Eurasian freight traffic has been and remains the trade between China and the EU, when speaking about the EAEU's competitive participation in transit, the latitudinal route "China - Europe - China" is most often meant. However, it is important that the development of continental routes already makes it possible to deliver cargo from the PRC to the EU and back, using separate highways that are part of the North-South ITC.

The Trans-Caspian International Transport Route (TITR) is positioned as an alternative to the Russian Trans-Siberian Railway for the delivery of goods from China to Europe and from Ukraine to Central Asian markets. In reality, in its current state, the route is still developing and the participating countries require investments to improve international logistics relations.

The Trans-Caspian International Transport Route (hereinafter referred to as TCIR) is a strategically important transport route connecting the regions of Eurasia via the Caspian Sea. This route connects the countries of Western Europe and Central Asia with the regions of the Near and Middle East. It is a key transport corridor providing efficient trade and cargo transport between different continents [3]. The Trans-Caspian Transport Route combines several routes, including railway, road, sea and even multimodal routes. It connects ports on the Caspian Sea with railway networks and motorways extending through Central Asian countries such as Kazakhstan, Turkmenistan and Uzbekistan. The route also provides access to the Persian Gulf countries and the onward movement of cargo to Europe via Mediterranean ports.

The Trans-Caspian transport route is an important infrastructure for cargo transit and the development of economic ties between different regions of Eurasia, contributing to the strengthening of trade relations and co-operation between countries. The cargo flow along the TITR is presented in Figure 1.

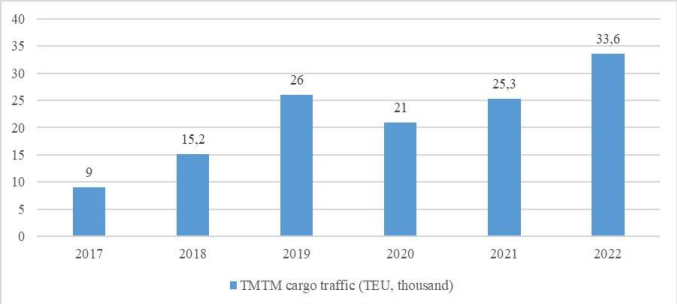

Figure 1. TITR cargo traffic (TEU, ths.). Note - compiled by the author on the basis of the source [4]

According to the presented Figure 3, In 2022, the volume of cargo traffic on the TITR route increased 2.5 times and reached 1.48 million tonnes. 33.6 thousand TEU were transported along the route - this is 33 per cent higher than last year's figure. Export of Kazakhstani cargoes increased 6.5 times compared to 2021 and amounted to 891 thousand tonnes. However, in 2022, there was a decline in transit traffic by 3.5% to 257.5 thousand tonnes, as well as in container traffic by 25% with the final volume of 11 thousand TEU.

2. Materials and methods

2.1. Literary review

Correlation and regression analysis are a powerful statistical analysis tool that allows us to examine the relationships between variables and determine the extent to which key factors influence traffic volumes along the Trans-Caspian International Transport Route. First, it is necessary to identify the key factors that may have an impact on transport volumes along the Trans-Caspian route. These may include, for example, economic indicators, political factors, transport network infrastructure, customs procedures and others. Next, data is collected on traffic along the route and on the values of the selected key factors over a certain period of time.

The first step of the analysis is to determine the correlations between variables [4]. Correlation analysis allows to identify the degree of relationship between traffic volumes and other factors. For example, it is possible to determine whether there is a statistically significant relationship between the economic growth of a region and transport volumes.

After conducting correlation analysis, we can proceed to regression analysis, which allows us to assess the degree of influence of selected factors on traffic volumes. A regression model can be built to forecast traffic volumes based on the values of key factors [5]. The obtained results of correlation and regression analysis allow us to draw conclusions about which factors have the greatest influence on the volumes of transportations along the Trans-Caspian route. These conclusions can be used to optimize logistics processes, improve infrastructure and make strategic decisions in the field of cargo transportation through this route.

At the same time, there are a number of factors affecting the development of transit routes on TITR in Kazakhstan. In order to identify the most significant factors, a study was conducted using correlation and regression analysis. At the initial stage, information was collected regarding the costs of 150 Kazakhstani transport and logistics and freight forwarding companies for interaction with various elements of logistics infrastructure for the period 2014-2023. The data were collected by KazLogistics NCO, which conducted a large-scale study of the state of logistics infrastructure in the Kazakhstani section of the TITR, namely:

- Costs of Kazakhstani companies to interact with the institutional element;
- Costs for companies to engage with the public element;
- Costs for companies to interact with the scientific component;
- Costs for companies to interact with the regulatory element;
- Costs for companies to interact with the technical element.

The interaction of companies with the institutional element of the logistics infrastructure of the international Trans-Caspian transport route is a complex process that involves identifying and optimising the costs of transporting cargo through this route, as well as interacting with the institutional structures that regulate and ensure the functioning of the logistics infrastructure. The costs for companies to use the Trans-Caspian transport route include freight transport costs, customs duties, cargo insurance, and other operational costs. Effective management of these costs requires not only optimization of logistics processes, but also interaction with institutional elements of logistics infrastructure, such as ports, railway and road transport companies, customs services and other participants in the logistics chain. The institutional elements of the logistics infrastructure of the international Trans-Caspian transport route play a key role in ensuring the effective functioning of this route. These elements include laws, regulations, rules and procedures governing transport operations, customs clearance, cargo security and other aspects of logistics activities.

The interaction between transport companies and the institutional element of logistics infrastructure on the example of the international Trans-Caspian transport route is a complex process involving the coordination of private and public actors to ensure the efficient transport of goods through this route. Transport companies act as the key players responsible for organizing and executing transport, while institutional elements of logistics infrastructure, such as ports, railway and road transport companies, customs services and others, provide the necessary infrastructure and services to support this process [6]. Effective interaction between transport companies and institutional elements of logistics infrastructure requires consideration of various aspects, including route optimization, coordination of schedules, cargo security and customs formalities. In addition, economic, legal and regulatory aspects need to be considered in order to ensure consistency among all participants and minimize risks and costs.

Public elements of logistics infrastructure play a key role in ensuring the stability and reliability of cargo transport via the Trans-Caspian transport route. They provide necessary services, regulate the activities of participants and contribute to the reduction of administrative barriers for more efficient functioning of the international logistics chain. Thus, the interaction of transport companies with the institutional element of logistics infrastructure on the Trans-Caspian transport route is a complex process that requires careful planning, coordination and management to ensure the efficient and safe transport of goods through the route.

The interaction of transport companies with the scientific element of the logistics infrastructure on the international Trans-Caspian transport route is a complex mechanism based on the principles of joint work and integration of various components to ensure the efficient transport of goods. Transport companies play a key role in the organization and execution of transport via the Trans-Caspian transport route, coordinating the various stages of transport, from planning and management to physical delivery of cargo. They have expertise in logistics and transportation, which enables them to optimize routes, select the most appropriate modes of transport and ensure reliable delivery [7]. Scientific elements of logistics infrastructure, in turn, are a set of innovative technologies, methods and approaches aimed at optimizing transportation processes and improving the efficiency of logistics operations. These elements include the use of modern information systems, analytical tools, automated processes and other scientific and technological developments to improve productivity and service quality.

The interaction of transport companies with the regulatory element (including accounting and legal support) of the logistics infrastructure on the international Trans-Caspian transport route is a complex and important process based on joint work and harmonization of various aspects of activities. Transport companies involved in organizing transport via the Trans-Caspian transport route face a variety of regulatory

issues, including tax legislation, customs procedures, international trade rules and other aspects requiring accounting and legal support.

The interaction of transport companies with the technical element of the logistics infrastructure on the international Trans-Caspian transport route represents a key aspect in ensuring the efficiency and reliability of transport through this route. Technical support and the development of meaningful technical solutions play an important role in optimizing transport processes, increasing cargo security and improving the overall performance of the logistics system [8]. Technical support includes support and maintenance of transport equipment, use of advanced technologies in the field of transportation and cargo monitoring, as well as development and implementation of innovative solutions to optimize logistics processes. This allows to improve the efficiency of resource utilization, reduce time costs of transportation and improve the quality of customer service.

3. Results and discussion

The development of significant technical solutions is aimed at improving transport infrastructure, including technical means of transport, cargo monitoring and management systems, and communication technologies. These solutions contribute to increasing route capacity, reducing cargo delivery time and improving the overall competitiveness of the logistics system. Thus, interaction of transport companies with the technical element of logistics infrastructure on the Trans- Caspian transport route is a necessary condition for ensuring the efficiency and reliability of international transport. Technical support and development of innovative technical solutions play an important role in optimizing logistics processes and ensuring a high level of service for customers, contributing to the development of the Trans-Caspian transport route as a key element of global logistics. In the next paragraph we will present the data of correlation and regression analysis to determine the peculiarities of interaction of these elements with the volume of traffic on the Kazakhstan section of the TITR.

Correlation and regression analysis allow us to identify and assess the impact of various factors on the volume of traffic along the Trans-Caspian international transport route, which can be useful for optimizing logistics processes and improving the efficiency of this transport direction. Let us present the correlation-regression analysis of the presented data. Initiative matrix for the production of the analysis is presented in Table 1.

Table 1. Initiative matrix for analysis production

Period	Y transport volume	X1 Institutional element	X2 Public element	X3 Research element	X4 Regulatory element	X5 Technical element
2014	2.8	8.63	4.93	1.36	6.54	1.97
2015	3.4	10.39	5.72	1.43	7.29	2.26
2016	4.1	9.44	5.54	1.47	6.97	2.17
2017	9.0	6.35	3.96	1.15	4.96	1.57
2018	15.0	4.87	2.81	0.85	3.46	1.10
2019	26.0	7.39	4.53	1.38	5.32	2.01
2020	21.0	7.59	4.23	1.24	4.88	2.00
2021	25.3	7.18	4.62	1.43	5.30	2.14
2022	33.6	8.01	4.30	1.12	5.18	2.11
2023	36.9	8.73	5.44	1.75	6.94	2.83
Note - compiled by the author on the basis of the source [9]						

According to Table 1, the period of analysis covers 10 years from 2014 to 2023. The multiple regression equation can be represented as (formula 1):

$$Y = f(\beta , X) + \varepsilon \quad (1)$$

where X = X(X1, X2, ..., Xm) - is a vector of independent (explanatory) variables; β - vector of parameters (to be determined);

ε - random error (deviation);

Y-dependent (explained) variable.

The theoretical linear multiple regression equation has the form presented in formula 2:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_m X_m + \varepsilon \quad (2)$$

β0 is the free term that determines the value of Y when all explanatory variables Xj are 0. The regression equation (estimation of the regression equation) in standard form is as follows:

$$Y=31.2006-6.9541X_1+0.8632X_2+38.8395X_3+.1116X_4+ 58.245X_5 \quad (3)$$

Interpretation of regression coefficients. The constant estimates the aggregate effect of factors other than xi accounted for in the model on the outcome Y and means that Y would have been 31.2006 in the absence of xi. The coefficient b1 indicates that as x1 increases by 1, Y increases by 6.9541. The coefficient b2 indicates that as x2 increases by 1, Y increases by 0.8632. The coefficient b3 indicates that as x3 increases by 1, Y increases by 38.8395. The coefficient b4 indicates that as x4 increases by 1, Y increases by 5.1116. The coefficient b5 indicates that as x5 increases by 1, Y increases by 58.245. To estimate the correlation equation, let us determine the dynamics of the paired correlation coefficients.

Pairwise correlation is an important statistical tool for estimating the regression equation. It measures the degree of linear relationship between two variables, which allows us to determine how much one variable change when the other variable changes. Pairwise correlation is usually expressed by the Pearson correlation coefficient, which can take values from -1 to 1. When we build a regression model, pairwise correlation helps us understand which variables should be included in the regression equation. If two variables have a high positive correlation, this may indicate that they are related and may influence each other. In such a case, including both variables in the regression model may lead to multicollinearity.

On the other hand, if the variables have low or negative correlation, it may mean that they are independent of each other and including both variables in the regression model may be more appropriate to explain the variability of the dependent variable. Thus, pairwise correlation plays an important role in selecting variables to construct the regression equation, helping researchers to determine the best combination of predictors to explain the variability of the dependent variable and create a more accurate and interpretable model. The significance of correlation coefficients is presented in Table 2.

According to Table 2, the value of correlation coefficients indicates the presence of relationship between the variables.

Table 2. Value of correlation coefficients

Signs x and y	$\sum x_i$	$\overline{x} = \frac{\sum x_i}{n}$	$\sum y_i$	$\overline{y} = \frac{\sum y_i}{n}$	$\sum x_i * y_i$	$\overline{x * y} = \frac{\sum x_i * y_i}{n}$
1	2	3	4	5	6	7
For y and x_1	78.58	7.858	177.1	17.71	1352.851	135.285
For y and x_2	46.08	4.608	177.1	17.71	802.468	80.247
For y and x_3	13.18	1.318	177.1	17.71	238.103	23.81
For y and x_4	56.84	5.684	177.1	17.71	973.239	97.324
For y and x_5	20.16	2.016	177.1	17.71	376.452	37.645
For x_1 and x_2	46.08	4.608	78.58	7.858	373.793	37.379
For x_1 and x_3	13.18	1.318	78.58	7.858	106.039	10.604
For x_1 and x_4	56.84	5.684	78.58	7.858	462.812	46.281
For x_1 and x_5	20.16	2.016	78.58	7.858	163.3	16.33
For x_2 and x_3	13.18	1.318	46.08	4.608	62.41	6.241
For x_2 and x_4	56.84	5.684	46.08	4.608	271.175	27.117
For x_2 and x_5	20.16	2.016	46.08	4.608	95.89	9.589
For x_3 and x_4	56.84	5.684	13.18	1.318	77.128	7.713
For x_3 and x_5	20.16	2.016	13.18	1.318	27.471	2.747
For x_4 and x_5	20.16	2.016	56.84	5.684	118.443	11.844
Note - compiled by the author on the basis of the source [9]						

Analysis of variance and standard deviations play an important role in evaluating the regression equation and determining its quality. When building a regression model, we aim to find the equation that best explains the variability in the dependent variable based on the independent variables. Analysis of variance helps us to assess how well the regression equation fits the data by comparing actual observations with the predicted values of the model. The standard deviation (sum of squares of the residuals) is a measure of the difference between the actual values of the dependent variable and their predicted values from the regression equation. The smaller the standard deviation, the closer the predicted values are to the actual values, indicating a better model fit.

Analysis of variance allows the total variability in the data to be estimated and divided into explained and unexplained parts. Explained variance is related to the effect of independent variables on the dependent variable through the regression equation, while unexplained variance reflects random variability in the data. As the level of explained variance increases, we get a better fit of the regression model to the initial data. Thus, analysis of variance and standard deviations help researchers assess the quality of the regression model, identify the significance of the influence of independent variables and determine how well the model fits the data, which is important for making informed decisions based on the results of regression analysis.

In Table 3, we present the matrix of pairwise correlation coefficients R:

Table 3. Matrix of paired correlation coefficients R

	y	x_1	x_2	x_3	x_4	x_5
	1	0.2158	0.1369	0.1683	0.2412	0.3786
x_1	0.2158	1	0.9512	0.7176	0.9435	0.7694
x_2	0.1369	0.9512	1	0.8808	0.9773	0.853
x_3	0.1683	0.7176	0.8808	1	0.8346	0.9165
x_4	0.2412	0.9435	0.9773	0.8346	1	0.7884
x_5	0.3786	0.7694	0.853	0.9165	0.7884	1
Note - compiled by the author on the basis of the source [9]						

According to Table 3, the matrix of paired correlation coefficients R indicates that there is a definite linear relationship between the variables.

According to the presented analysis, the value of the standard error coefficient is within the acceptable values of less than 20%, which indicates the relevance of the constructed regression equation.

The elasticity coefficient is an important measure in econometrics and statistics used to estimate the regression equation. It represents the relative change in the dependent variable in response to an absolute change in the independent variable. The elasticity coefficient measures the sensitivity of the dependent variable to changes in the independent variable. Formally, the elasticity coefficient is defined as the derivative of the logarithm of the dependent variable by the logarithm of the independent variable. This approach allows us to consider the percentage change in the variables rather than just their absolute changes, which makes the interpretation of the coefficient more convenient and intuitive. The elasticity coefficient can be positive, negative or zero, indicating varying degrees of relationship between variables. A positive coefficient means a direct relationship between variables (an increase in one variable leads to an increase in another), a negative coefficient means an inverse relationship (an increase in one variable leads to a decrease in another), and zero means no relationship.

Let us present the elasticity coefficient analysis matrix in the following Table 4.

Table 4. Matrix of elasticity coefficient analysis

Ratio index	Significance	Interpretation
E1	3.86%	The effect on the resultant attribute is significant.
E2	0.225%	The effect on the resultant trait is not significant.
E3	2.89%	The effect on the resultant attribute is significant.
E4	1.641%	The effect on the resultant attribute is significant.
E5	6.63%	The effect on the resultant attribute is significant.
Note - compiled by the author on the basis of the source [9]		

According to the analysis presented in Table 4, 4 out of 5 analysed factors have a significant impact on the resulting trait, as the value of the obtained elasticity coefficients exceeds 1%.

To assess the degree of influence of logistics infrastructure elements on the volume of freight traffic, we calculated the elasticity coefficient, according to which 4 out of 5 elements of logistics infrastructure have a significant impact on the volume of traffic on the Kazakhstan section of the route. The influence of the public element on the volume of traffic is the most insignificant. The matrix of pair correlation coefficients R confirms the statistical significance of the analysis, as there is a non-linear relationship between the coefficients [10].

4. Conclusions

International transport routes are an interconnection of nodal transport and logistics corridors located within the borders of several states and combining elements of international logistics infrastructure at different parts of the chain. Effective functioning of transport and logistics infrastructure of international transport routes is impossible without its constituent elements, which include institutional, public, research, regulatory and technical elements.

Correlation and regression analysis can be used to analyse the performance of logistics infrastructure. Correlation and regression analysis can be a useful tool for assessing and optimising logistics infrastructure by identifying key factors affecting its performance and developing strategies to improve the performance of logistics systems.

To assess the degree of influence of logistics infrastructure elements on the volume of freight traffic, we calculated the elasticity coefficient, according to which four (institutional, research, regulatory element, technical elements) out of five elements of logistics infrastructure have a significant impact on the volume of traffic on the Kazakhstan section of the route. The influence of the public element on the volume of traffic is the most insignificant. The matrix of pair correlation coefficients R confirms the statistical significance of the analysis, as there is a non-linear relationship between the coefficients. Thus, we have obtained the data of quantitative measurement of the impact of various elements of logistics infrastructure on the volume of traffic on the Kazakh section of the TITR, which confirms the importance and the need for the development of Kazakh infrastructure.

References

[1] Zhumanov, A.U., Kegenbekov, Zh.K. & Toluev, Y.I. (2024). State of logistics development and transit potential of international corridors of the Republic of Kazakhstan. *Bulletin of Turan University, (4), 200-212.* https://doi.org/10.46914/1562-2959-2024-1-4-200-212

[2] Kenderdine, T. & Bucsky, P. (2021). Middle Corridor-Policy Development and Trade Potential of the Trans-Caspian International Transport Route. *ADB Economics Working Paper Series*

[3] Alirbayevu, A. & Jakubayeva, S. (2024). The Geopolitical and Geo-Economic significance of the «Middle Corridor» for Kazakhstan. *International relations and international law Journal, 106(2), 89-102.* https://doi.org/10.26577/IRILJ.2024.v106.i2-09

[4] Kovshun, N., Solodkyy, V., Nalyvaiko, N., Syrotynska, A. (2024). Using correlation and regression analysis methods to assess the effectiveness of environmental projects. *IOP Conference Series Earth and Environmental Science, 1429(1), 012012.* https://doi.org/10.1088/1755- 1315/1429/1/012012

[5] Pandey, Shivam. (2020). Principles of Correlation and Regression Analysis. *Journal of the Practice of Cardiovascular Sciences 6(1), 7-11*. https://doi.org/10.4103/jpcs.jpcs_2_20

[6] Khadim, Z. (2021). Mapping the moderating role of logistics performance of logistics infrastructure on economic growth in developing countries. *Economies, 9(4), 177.* https://doi.org/10.3390/economies9040177

[7] Metelenko, N.G., Kovalenko O.V. (2018). Infrastructure and conceptual basis of transport logistics. *Economic Bulletin of the Zaporozhye State Engineering Academy, 2, 76-79*

[8] Korczak, J., Sasin, M. & Janiszewska, D. (2021). Smart logistics infrastructure in peripheral region. European research studies journal XXIV, 535-548. https://doi.org/10.35808/ersj/2787

[9] Report of NCO «KazLogistics Union» on the activities of the Trans-Caspian International Transport Route. (2024)

[10] Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. (2024). Statistical compilation of collected customs duties within the Trans-Caspian International Transport Route 2013-2023.

Транскаспий көлік бағыты бойынша Қазақстан Республикасының транзиттік әлеуеті факторларын талдау

Ж.М. Тымбаева, Н.Ж. Толқынбек*, Д.Н. Сейлхан

Satbayev University, Алматы, Қазақстан

**Корреспонденция үшін автор: n.tolkynbek@satbayev.university*

Аңдатпа. Осы мақалада Транскаспий көлік бағыты бойынша транзиттік тасымалдарды дамытуға елеулі әсер ететін факторлар зерттеледі. Қазіргі уақытта Қазақстан Республикасы Қытай мен Еуропа арасындағы түйіскен жерде Еуразиялық кеңістік ішіндегі көлік жолдарын дамытудың айқындаушы факторларының біріне айналуда. ЕАЭО аумағы арқылы ендік және меридиандық халықаралық көлік дәліздері (ККМ) – "Шығыс – Батыс" және "Солтүстік – Оңтүстік"бағыттарындағы маршруттар өтеді. Аймақтың географиясы әртүрлі көлік түрлерін біріктіре отырып, тек құрлық жолдарымен де, мультимодальды жолдармен де жеткізуге мүмкіндік береді. Зерттеу ашық көздерден алынған мәліметтерге негізделген корреляциялық-регрессиялық талдауды қолдану арқылы жүргізілді. Алынған нәтижелер Қазақстанда транзиттік тасымалдарды дамыту үшін жағдай жасайтын неғұрлым маңызды факторларды анықтауға мүмкіндік берді.

Негізгі сөздер: *көлік маршруты, институционалдық элемент, қоғамдық элемент, ғылыми компонент, халықаралық жүк тасымалдау, шығындар.*

Анализ факторов транзитного потенциала Республики Казахстан по Транскаспийскому транспортному маршруту

Ж.М. Тымбаева, Н.Ж. Толқынбек*, Д.Н. Сейлхан
Satbayev University, Алматы, Казахстан
**Автор для корреспонденции: n.tolkynbek@satbayev.university*

Аннотация. В настоящей статье исследуются факторы, оказывающие значительное влияние на развитие транзитных перевозок по Транскаспийскому транспортному маршруту. В настоящее время Республика Казахстан становится одним из определяющих факторов развития транспортных путей внутри Евразийского пространства на стыке между Китаем и Европой. По территории ЕАЭС пролегают широтные и меридиональные международные транспортные коридоры (МТК) – маршруты в направлении «Восток – Запад» и «Север – Юг». География региона позволяет осуществлять доставку как исключительно сухопутными способами, так и мультимодальными, комбинируя различные виды транспорта. Исследование было проведено с применением корреляционно-регрессионного анализа на основе данных с открытых источников. Полученные результаты позволили определить наиболее значимые факторы, развитие которых создадут условия для развития транзитных перевозок в Казахстане.

Ключевые слова: *транспортный маршрут, институциональный элемент, публичный элемент, научная составляющая, международные грузоперевозки, затраты.*

Received: 03 December 2024
Accepted: 16 March 2025
Available online: 31 March 2025