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The Economic Potential of the Regions of Kazakhstan: Comparative Analysis and Regional Accessibility

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ABSTRACT

This study examines the relationship between regional accessibility and economic potential in Kazakhstan based on empirical data processing. The study shows that transport infrastructure, measured by the length of roads and railways, is one of the decisive factors affecting regional accessibility. The structure of the study consists of four essential stages: data collection; identification of leading directions; correlation and regression analysis; substantiation of conclusions, and recommendations. The variables used in the comparative analysis are the operational length of railway lines, the length of public roads and the gross regional product. The correlation and regression analysis results revealed significant links between the length of railways and highways and the gross regional product (GRP) of the selected regions. The obtained models for South Kazakhstan, North Kazakhstan and Karaganda regions showed high positive relationships based on high values of R-squares. The study results showed that the variables included in these models strongly correlate with the overall regional changes in output and better explain their positive relationships. The study emphasizes the importance of taking into account regional differences in infrastructure development and economic indicators. As a result of the results obtained, conclusions should be drawn, and recommendations should be made policy makers can use that to promote balanced and inclusive regional development by reducing inequality.

KEYWORDS: Regional Economic System, Rural, Spatial, Urban, Mass Transit, Railways, Regional Transportation, Transportation Economics

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Қазақстан аймақтарының экономикалық әлеуеті: салыстырмалы талдау және аймақтық қолжетімділік

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ТҮЙІН

Бұл зерттеуде эмпирикалық деректерді өңдеу негізінде Қазақстандағы өңірлік қолжетімділік пен экономикалық әлеует арасындағы өзара байланыс қарастырылады. Зерттеу көрсеткендей, автомобиль мен теміржол жолдарының ұзындығымен өлшенетін көлік инфрақұрылымы аймақтық қолжетімділікке әсер ететін шешуші факторлардың бірі болып табылады. Зерттеу құрылымы төрт маңызды кезеңнен тұрады: мәліметтер жинау; жетекші бағыттарды анықтау; корреляциялық-регрессиялық талдау; қорытындылар мен ұсыныстарды негіздеу. Салыстырмалы талдауда қолданылатын айнымалылар теміржол желілерінің пайдалану ұзындығы, жалпыға ортақ пайдаланылатын автомобиль жолдарының ұзындығы және жалпы өңірлік өнім болып табылады. Корреляциялық-регрессиялық талдау нәтижелері темір жолдар мен автомобиль жолдарының ұзындығы мен таңдалған өңірлердің жалпы өңірлік өнімі (ЖӨӨ) арасындағы маңыз бар байланыстарды анықтады. Оңтүстік Қазақстан, Солтүстік Қазақстан және Қарағанды облыстары үшін алынған модельдер R-квадраттардың жоғары мәндері негізінде жоғары оң байланыстарды көрсетті. Зерттеу нәтижелері осы модельдерге енгізілген айнымалылар жалпы аймақтық өндіріс көлемінің өзгеруімен тығыз байланысты екенін және олардың оң байланыстарын жақсырақ түсіндіретінін көрсетті. Зерттеу инфрақұрылым мен экономикалық көрсеткіштердің дамуындағы аймақтық айырмашылықтарды ескерудің маңыздылығын көрсетеді. Алынған нәтижелердің негізінде саясаткерлер теңсіздікті азайту арқылы теңгерімді және инклюзивті аймақтық дамуды ілгерілету үшін пайдалана алады.

ТҮЙІН СӨЗДЕР: аймақтық экономикалық жүйе, ауылдық, кеңістіктік, қалалық, массалық транзит, темір жол, аймақтық көлік, көлік экономикасы

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Экономический потенциал регионов Казахстана: сравнительный анализ и региональная доступность

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АННОТАЦИЯ

В этом исследовании рассматривается взаимосвязь между региональной доступностью и экономическим потенциалом в Казахстане на основе обработки эмпирических данных. Исследование показывает, что транспортная инфраструктура, измеряемая протяженностью автомобильных и железных дорог, является одним из решающих факторов, влияющих на региональную доступность. Структура исследования состоит из четырех важных этапов: сбор данных; определение ведущих направлений; корреляционно-регрессионный анализ; обоснование выводов и рекомендаций. Переменными, используемыми в сравнительном анализе, являются эксплуатационная протяженность железнодорожных линий, протяженность автомобильных дорог общего пользования и валовой региональный продукт. Результаты корреляционно-регрессионного анализа выявили значимые связи между протяженностью железных и автомобильных дорог и валовым региональным продуктом (ВРП) выбранных регионов. Полученные модели для Южно-Казахстанской, Северо-Казахстанской и Карагандинской областей показали высокие положительные связи на основе высоких значений R-квадратов. Результаты исследования показали, что переменные, включенные в эти модели, сильно коррелируют с общими региональными изменениями объема производства и лучше объясняют их положительные связи. В исследовании подчеркивается важность учета региональных различий в развитии инфраструктуры и экономических показателей. В результате полученных результатов следует сделать выводы и дать рекомендации, которые могут быть использованы политиками для содействия сбалансированному и инклюзивному региональному развитию за счет сокращения неравенства.

КЛЮЧЕВЫЕ СЛОВА: региональная экономическая система, сельская, пространственная, городская, общественный транспорт, железные дороги, региональный транспорт, экономика транспорта

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Introduction

Research aimed at studying the impact of transport infrastructure development on the economic growth of countries and regions has recently been of great importance in the country's sustainable development. It is assumed that the development of roads and railways increases the accessibility of regions, thereby improving their competitiveness and economic potential.

In the last decade, the state has paid increased attention to infrastructure development in Kazakhstan. Between 2010 and 2021, the total length of paved roads increased by more than 10%. In addition, there is a significant overhaul of autobahns and highways between regions and countries for international cooperation. At the same time, the length of the railways in the aggregate did not undergo significant changes, and in some areas, there was even a reduction in the railway infrastructure. Meanwhile, the total GRP of the Republic of Kazakhstan regions for the same period in relative terms increased by 80%. From a scientific point of view, it seems essential to establish a quantitative relationship between infrastructure development and individual regions' development.

Studies of recent events are widely disseminated, and they confirm the positive impact of the development of the transport situation on the economic growth of countries and regions. The development of road and rail networks plays an essential role in the concentration and specialization of production, the effective use of countries and economic regions, the effective use of vehicles in the final cost of goods and the achievement of access to a new market. The Republic of Kazakhstan is a large country with diverse economic potential in its different regions. Logistics development in regions plays a key role in determining economic potential. Thus, transport infrastructure is a key factor for regional accessibility development. It improves the development of new economic clusters, and economic relations and has a big influence on internal tourism (Yang & McCarthy, 2013; Raimbekov et al., 2017; Aliyeva et al., 2019; Mukhametzhan et al., 2020; Dmitriyev et al., 2021; Sergeyeva et al., 2022)

Transport infrastructure is a crucial element in the dialogue not within regions but among countries' economic relations as well. Firstly, there is the interdependence of industrial development and logistics. Therefore, it determines the amount of foreign direct investments, and the amount of state budget provided for the improvement of roads (Ashurov et al., 2020; Saidi et al., 2020). Secondly, logistics development leads to transport infrastructure improvement and the development of new clusters, which promotes collaboration within the private sector and provides efficacy in logistics operations (Thill & Lim, 2010; Kumar et al., 2017; Otsuka et al., 2017; Dannenberg et al., 2018; Le et al., 2019). Thirdly, in the case of Kazakhstan, great attention is given to the development of transport infrastructure and commuting systems along the Silk Road (Dave & Kobayashi, 2018; Chan, 2018; Bitabarova, 2018; Pomfret, 2019).

The development of transport clusters and infrastructure is taken as the main indicator in the analysis of logistics impact on the socio-economic development of regions. Some studies highlight the transformative impact of the development of high-speed rails on social and economic relationships among cities and emphasize the importance of addressing regional disparities (Wang et al., 2020; Cascetta et al., 2020; Yu et al., 2019; Liang et al., 2020).

The study of the quantitative relationship between infrastructure development and individual regions' development is important from a scientific point of view. On the one hand, transport infrastructure is a public good with low, and sometimes even zero, returns. On the other hand, the need for a developed transport network often becomes a serious obstacle to implementing large investment projects that are not ready to bear such costs. In Kazakhstan, there is a small number of studies on the assessment of the contribution of infrastructure to economic growth, and they need to provide a clear answer about the presence of a statistically significant impact. This study will examine the relationship between transport infrastructure and the economic development dynamics of Kazakhstan's regions.

The goal of this research is to analyze the relationship between regional accessibility, as measured by transport infrastructure, and economic potential in different regions of Kazakhstan. The study aims to provide a comprehensive understanding of the role of logistics development in promoting regional accessibility and economic development, by employing a combination of empirical analysis and literature review methods, the research aims to identify the key factors influencing regional accessibility and economic potential in Kazakhstan and highlight the challenges and opportunities for economic development in the country's various regions. Ultimately, the research aims to contri-

bute to the knowledge base on logistics development and its implications for regional economic potential in Kazakhstan.

Literature review

Logistics plays a crucial role in promoting regional accessibility and economic development not only in Kazakhstan but also in developed countries. The experience of developed countries can provide valuable insights into how improvements in logistics infrastructure can enhance regional accessibility and promote economic growth.

Transport infrastructure and connectivity are crucial factors in attracting investment and promoting economic growth in Kazakhstan (Yang & McCarthy, 2013; Mukhametzhan et al., 2020). The development of transportation infrastructure is necessary for economic growth and regional integration in Central Asia, including Kazakhstan (Raimbekov et al., 2018). Dmitriyev et al. (2021) explored the relationship between regional accessibility and economic diversification in Kazakhstan. The potential of northern Kazakhstan's lakes for economic use and tourism development is hindered by limited current utilization and insufficient tourist infrastructure. Despite its favorable location and well-developed transport routes, the region's low road network density poses a challenge to accessibility. Further research is needed to ensure sustainable ecosystem management and provide recommendations for facility development to preserve their value. The study found that regions with better accessibility and transport connectivity had a more diversified economy, which led to higher economic growth and development (Aliyeva et al., 2019; Sergeyeva et al., 2022).

In Japan, the development of logistics clusters, which are concentrations of logistics activities and infrastructure, has been a key strategy for promoting regional development. These clusters have been successful in promoting collaboration between businesses and improving the efficiency of logistics operations (Kumar et al., 2017; Dannenberg et al., 2018). For example, in the United States, the development of intermodal transportation systems, which allow for the efficient movement of goods between different modes of transportation, has been instrumental in improving regional accessibility (Thill & Lim, 2010). Similarly, in the European Union, the development of the Trans-European Transport Network has led to increased connectivity between different regions and facilitated the movement of goods and services (Otsuka et al., 2017). In China, the development of logistics infrastructure clusters has been a key driver of economic growth in the country. The construction of new highways, railways, and ports has improved connectivity between regions and facilitated the movement of goods and services. Similarly, in Russia, the development of logistics infrastructure has been a priority for the government in recent years, with a focus on improving the efficiency of transport and reducing logistics costs (Le et al., 2019).

Additionally, regional accessibility has a direct impact on trade and foreign direct (FDO) investment flows. It determines the location of foreign direct investment, in particular, in Kazakhstan. Thus, regions with better accessibility have higher levels of foreign direct investment, which contributed to regional economic growth (Ashurov et al., 2020). A bi-directional relationship was revealed between economic growth, FDI inflows, and transport infrastructure. Therefore, governments should improve transport and logistics sustainability, develop urban logistics centres, and upgrade transport systems to increase FDI inflows and stimulate economic development. Solutions differ based on various factors, including geographical location. In particular, coastline regions have the opportunity to boost FDI through the development of maritime and railway transport, which can enhance commercial exchanges and improve competitiveness. These countries can also play a crucial role in international trade by upgrading ports, developing logistics platforms, and improving land transport systems (Saidi et al., 2020).

More importantly, it has a great impact on economic relations between countries along the Silk Road including Kazakhstan, China and Russia. The Belt and Road Initiative (BRI), launched by China in 2013, aims to enhance connectivity and promote trade and investment between China and countries along the Silk Road, including Russia and Kazakhstan (Dave & Kobayashi, 2018; Chan, 2018). In Kazakhstan, improvements in logistics infrastructure along the Silk Road have also been a key focus of the BRI. For example, the construction of the Khorgos Gateway, a logistics hub located on the border between Kazakhstan and China, has facilitated the movement of goods between the two countries (Bitabarova, 2018). Similarly, the development of the Eurasian Land Bridge, a rail network connecting China with Europe via Russia and

Kazakhstan, has reduced transport times and improved connectivity between regions (Pomfret, 2019).

It is important to note that regions with a high length of railway lines may have advantages in economic development. For example, rail infrastructure can help increase the volume of freight and passenger transportation, as well as the development of tourism. The ongoing development highlights the importance of logistics infrastructure in enhancing connectivity between regions and promoting trade and investment (Wang et al., 2020). High-speed rail has had significant effects on travel demand, per capita GDP growth, and rail-based accessibility. The development of high-speed rail provides economic, transport, and social impacts. For instance, in Italy, the impact of high-speed rails is estimated to have contributed to a 2.6% average increase in per capita GDP over ten years, with higher growth for areas directly connected to the HSR network. Accordingly, it increased inequalities between areas served by high-speed rails and those excluded (Cascetta et al., 2020). High-speed rails are believed to promote economic growth by reducing trade costs and facilitating the flow of economic activity.

Yu et al. (2019) examined the impact of high-speed rail connections on local GDP per capita. The results showed that connected peripheral regions experience a decrease in GDP per capita compared to non-connected regions. Moreover, network connections reduce GDP per capita in non-targeted peripheral areas (Lin et al., 2020). Nevertheless, high-speed rail construction does not produce a significant corridor effect or increase economic growth in the short term. Liang et al. (2020) showed that in China the effect varied spatially, with a more significant impact observed in certain areas outside the one-hour traffic circle. It influenced investment, industrial restructuring, and accessibility, leading to economic growth in some areas along the route.

The main variable used in all the studies is transport infrastructure, measured in terms of the length of roads, railways, and air routes. However, the impact of transport infrastructure on economic development is not uniform across all regions. Some studies highlight the presence of regional disparities, with certain regions having better transport infrastructure and economic opportunities than others. The studies consistently find that regions with better transport infrastructure tend to have higher economic growth and development levels. The variables used in these studies provide valuable insights into the factors that shape the impact of logistics development and economic potential in Kazakhstan.

Research Methodology

The research framework of the current study is based on the research of Liang et al. (2020). The study focuses on developed and less developed regions in China, including districts and counties along the high-speed rail and surrounding areas. These districts and counties are considered as the basic units for analysis.

The methodological structure of current research differs in the following way. The study was based on the provision of a literature review to identify critical factors affecting accessibility and development regions in Kazakhstan. The empirical analysis method involves the use of statistical data to analyze and evaluate the relationship between regional affordability and economic potential. But the variables describing accessibility vary from study to study. Therefore, it is important to identify critical factors. This study structure is presented in Figure 1.

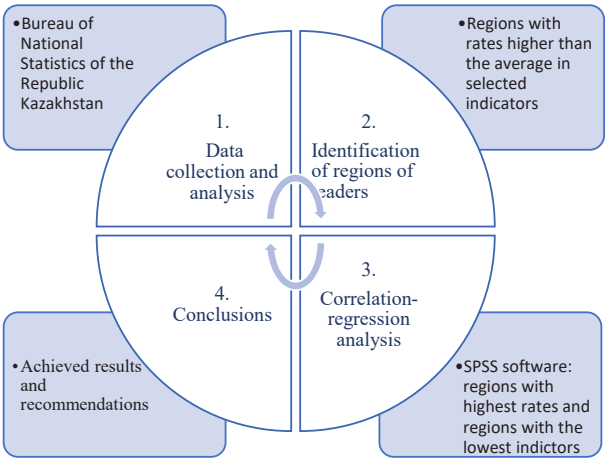

Figure 1- Stages of the study

Note: compiled by the authors

In the first stage, data collection will be carried out. The data source is the Bureau of National Statistics of the Republic of Kazakhstan. The data collected covers the period from 2011 to 2021 for the regions of Kazakhstan. The sample consists of fourteen regions and three cities. Next, a descriptive research method is used, and the data are compared between regions. Comparative analysis of the data

obtained is one of the fundamental analysis methods. It makes it possible to identify specific characteristics of the object of study and compare it in these parameters with other objects or with itself, but, for example, in different periods.

In the second stage, the leading regions will be selected, which have the highest rates, i.e. their performance should be above the national average. Next, A correlation regression analysis is used between indicators among the leading regions - the third stage to identify the relationship. Correlation-regression analysis is used to obtain objective information about the significance of the factor and the strength of its impact on the economic growth of regions. In addition, this analysis makes it possible to forecast and plan the development of regions and the country as a whole. SPSS software will be used here. The results will be interpreted.

Furthermore , conclusions will be drawn in the fourth stage, and proposals will be given.

The indicators that are used in this study related to the accessibility of the region are estimated by the transport infrastructure, which consists of two independent variables:

- the length of the operational length of railway lines;
- the length of public roads.

The dependent variable is the gross regional product. All variables are described in Table 1.

Table 1 – Research indicators

No.	Variable	Coding	Unit of measurement
1	Independent variables		
1.1	The length of the operational length of railway lines	Length_PR	Km
1.2	Length of public roads	Length_RW	Km
2	Dependent variables		
2.1	Gross regional product	GRP	KZT

Note: compiled by the authors

Overall, the variables used in these studies provide valuable information about the factors that determine the regional accessibility and economic potential of the regions of Kazakhstan. The results of this study can help inform policy decisions to promote a more balanced and inclusive development in the field of transport in frastructure for the development of regions.

Results and analysis

As of 2021, the length of the operational length of the railway lines of the Republic of Kazakhstan is about 16,800 km. Kazakhstan is located at the crossroads of major international transport corridors, and rail transport is an important component of the country's transport infrastructure. Railway lines in Kazakhstan allow for freight and passenger transportation both within the country and internationally. The increase in the length of railway tracks in the country is 12%, and an increase of 1686.2 km from 2011 to 2021 (see Table 2).

According to the table, the largest railway lines in terms of length are Karaganda, Aktobe and Almaty regions. They also show a high increase in this indicator in recent years. However, regions such as West Kazakhstan, Kostanay and Kyzylorda regions have significantly less rail lines. In terms of rail line growth, Karaganda has seen particularly strong growth in recent years, while oblasts such as Kostanay and Akmola have been declining.

When assessing the level of development of the railway infrastructure in general, one can pay attention to the ratio of the length of railway lines to the area of the region. For example, in the West Kazakhstan region, this ratio is the largest, which indicates a relatively high density of the railway network in this region. At the same time, the Almaty region, which has a relatively small length of railway lines, provides a dense railway connection with neighboring countries and a significant part of the international freight traffic through Kazakhstan. For example, West Kazakhstan Region has only 1,153 km of railway lines, one of the lowest in the table. However, it is worth noting that this area compensates for this with a high population density and the presence of developed road infrastructure.

Table 2 – The length of the operational length of the railway lines of Kazakhstan in 2011, 2015, 2016 and 2021, km

Regions	2011	2015	2016	2021	Growth	Increase
Total	14 319,4	14 767,1	15 529,8	16005,6	1 686,2	1,12
Akmola	1 559,0	1 559,0	1 559,0	1 565,8	6,8	1,00
Aktobe	1 431,5	1 431,5	1 486,5	1 817,3	385,8	1,27
Almaty	1 099,4	1 402,0	1 401,4	1 401,3	301,9	1,27
Atyrau	742,3	742,3	742,3	742,3	0,0	1,00
West Kazakhstan	1 205,7	319,7	319,7	319,7	-886,0	0,27
Zhambyl	1 043,5	1 043,5	1 043,5	1 029,1	-14,4	0,99
Karaganda	319,7	1 940,4	2 467,1	2 472,9	2 153,2	7,74
Kostanay	1 940,4	1 205,3	1 270,3	1 272,2	-668,2	0,66
Kyzylorda	1 205,3	754,9	870,9	870,9	-334,4	0,72
Mangystau	754,9	926,3	926,3	1 096,6	341,7	1,45
Pavlodar	787,8	787,8	788,4	766,0	-21,8	0,97
North Kazakhstan	618,7	618,7	618,7	618,7	0,0	1,00
Turkestan	784,5	551,6	551,6	548,7	-235,8	0,70
South Kazakhstan	551,6	1 209,0	1 209,0	1 209,0	657,4	2,19
Average length across the country	1 003,2	1 035,1	1 089,6	1 123,6	120,4	1,12

Note: compiled by the authors

In general, analyzing the data in the table, we can conclude that Kazakhstan has a developed railway infrastructure, however, the level of its development is not the same in different regions. Also, it must be taken into account that, in addition to railway lines, many other factors influence the development of the economy and the transportation of goods and services, such as the development of road and air infrastructure, the availability of free trade zones, etc.

Karaganda, Aktobe and Almaty regions are the three largest regions of Kazakhstan in terms of the length of railway lines.

Figure 2 - Indicators of the leading regions in terms of the length of the operational length of railway lines

Note: compiled by the authors

From these data, the following conclusions can be drawn:

(1) Karaganda region has the largest length of railway lines and the highest volume of traffic. It also makes the largest contribution to the republic's GDP.

(2) Aktobe region has a smaller length of railway lines but is still one of the largest regions in terms of traffic volume. Its contribution to the republic's GDP is less than 5%, reflecting the region's lower economic importance.

(3) Almaty region has a smaller length of railway lines and traffic volume than the other two regions, but is in second place in terms of growth of railway lines.

Since the study is aimed at regions where the indicator is above the average, according to calculations, the following regions remain Akmola, Almaty, Kostanay, Aktobe, Karaganda and East Kazakhstan regions. Based on the results of the analysis of the figure, the following conclusions can be drawn.

The largest railway lines in terms of length are Karaganda, Aktobe and Almaty regions. In 2021, the Karaganda region has the highest length of railway lines - 2472.9 km, which is 7.74% more than in 2020. The Aktobe region has 1,817.3 km of railways, which is 1.27% more than last year. The Almaty region also shows an increase in this indicator in recent years, the length of railways in 2021 amounted to 1401.3 km, which is 1.27% more than last year.

Regions, such as Kostanay and East Kazakhstan regions, have a significantly smaller length of railway lines. In Kostanay region, the length of railways in 2021 amounted to 1272.2 km, which is 0.66% more than in 2020. In the East Kazakhstan region, the length of railways was 1209 km, which is 2.19% more than last year. However, in general, the length of railway lines in these areas remains much lower than in the three largest areas. Akmola region in recent years has shown a decrease in the length of railway lines. In 2021, it amounted to 1565.8 km, which is 1% less than in 2020. In Table 2 there is given the second indicator - the length of roads in the republic.

Table 2 - Length of public roads in Kazakhstan in 2011, 2015, 2016 and 2021, km

Region	**2011**	**2015**	**2016**	**2021**	**Growth**	**Increase**
Total	97 155,0	96 529,0	96 353,0	95 443,0	-1 712,0	0,98
Akmola	7 886,0	7 891,0	7 890,0	7 988,0	102,0	1,01
Aktobe	6 091,0	6 553,0	6 958,0	6 831,9	740,9	1,12
Almaty	9 472,0	9 316,0	9 334,0	9 628,2	156,2	1,02
Atyrau	3 915,0	3 051,0	3 052,0	3 046,5	-868,5	0,78
West Kazakhstan	6 531,0	6 428,0	6 531,0	6 496,7	-34,3	0,99
Zhambyl	5 280,0	5 351,0	5 228,0	4 329,6	-950,4	0,82
Karaganda	8 844,0	8 844,0	8 854,0	8 780,6	-63,4	0,99
Kostanay	9 515,0	9 290,0	9 290,0	9 288,8	-226,2	0,98
Kyzylorda	3 338,0	3 354,0	3 376,0	3 047,0	-291,0	0,91
Mangystau	2 489,0	2 586,0	2 692,0	2 955,3	466,3	1,19
Pavlodar	5 665,0	5 659,0	5 454,0	6 673,5	1 008,5	1,18
North Kazakhstan	8 998,0	8 998,0	8 998,0	8 997,0	-1,0	1,00
Turkestan	7 289,0	7 197,0	6 810,0	5 382,3	-1 906,7	0,74
South Kazakhstan	11 842,0	12 011,0	11 886,0	11 997,6	155,6	1,01
Average length across the country	6 939,6	6 894,9	6 882,4	6 817,4	-122,3	0,98

Note: compiled by the authors based on the Bureau of National Statistics (2022)

The data represent the length of public roads in Kazakhstan and its regions from 2011 to 2021.

The total length of roads in Kazakhstan has decreased by 1,712 km, which is about a 2% decrease over the period from 2011 to 2021. At the same time, the length of motor roads in the number of regions of the country has increased, and in others, it has decreased.

Akmola region and Pavlodar region are leaders in the growth of the length of roads for the period from 2011 to 2021. Akmola region increased the length of its roads by 102 km, and Pavlodar region by 1008.5 km, which is an increase of 1.01 and 1.18 times, respectively.

On the other hand, Atyrau Region and Zhambyl Region reduced the length of their roads the most between 2011 and 2021. Atyrau region reduced the length of its roads by 868.5 km, and Zhambyl region by 950.4 km, which is a decrease of 0.78 and 0.82 times, respectively.

Thus, the data show a heterogeneous change in the length of roads in different regions of Kazakhstan for the period from 2011 to 2021.

The general trend of increasing the length of roads in the country may be associated with the development of the economy and an increase in the living standards of the population, which contributes to an increase in demand for transport services. However, it should be noted that in some regions of the country, the length of roads might not meet the demand for transport services, which may require additional investment in the development of transport infrastructure.

The following Table 3 highlights regions that perform above the national average.

Table 3 - Leading regions in terms of the length of roads in 2011, 2015, 2016 and 2021

Region	2011	2015	2016	2021
Akmola	7 886,0	7 891,0	7 890,0	7 988,0
Aktobe	6 091,0	6 553,0	6 958,0	6 831,9
Almaty	9 472,0	9 316,0	9 334,0	9 628,2
Karaganda	8 844,0	8 844,0	8 854,0	8 780,6
Kostanay	9 515,0	9 290,0	9 290,0	9 288,8
North Kazakhstan	8 998,0	8 998,0	8 998,0	8 997,0
South Kazakhstan	11 842,0	12 011,0	11 886,0	11 997,6

Note: compiled by the authors based on the Bureau of National Statistics (2022)

This table shows the length of roads in the regions of Kazakhstan in the period from 2011 to 2021. It can be seen from the table that the largest length of roads in Kazakhstan in 2021 is observed in the East Kazakhstan region - 11,997.6 km. In second place in terms of the length of roads is the Almaty region - 9,628.2 km.

It is also worth noting that the length of roads in each region remained approximately at the same level throughout the entire period. For example, the length of roads in the Akmola region varied from 7,884 km in 2017 to 8,111 km in 2012 but did not change significantly overall. In general, the table shows that Kazakhstan has a fairly developed road network that remains at about the same length for a long period of time. Next, a correlation-regression analysis will be carried out for regions with indicators above the average that we have determined, a relationship will be revealed between the length of railway lines and roads with GRP for each region under study.

Table 4 - Models' Summary

Model	R	R-square
1 Akmola_GRP	,151[a]	,023
2 Aktobe_GRP	,692[a]	,479
3 Almaty_GRP	,418[a]	,174
4 Karaganda_GRP	,761[a]	,580
5 Kostanay_GRP	,561[a]	,314
6 NKz_GRP	,742[a]	,550
7 SKz_GRP	,773[a]	,598

Note: compiled by the authors

The analysis focuses on seven models that examine the influence of independent variables on the Gross Regional Product (GRP) of seven regions: Akmola, Aktobe, Almaty, Karaganda, Kostanay, North Kazakhstan, and South Kazakhstan. The results indicate that the R-squared values are relatively high for SKz_GRP, NKz_GRP, and Karaganda_GRP, with values of 0.598, 0.550, and 0.580 respectively, compared to the other models. On the other hand, the Akmola_GRP and Almaty_GRP models demonstrate the lowest R-squared values, with 0.023 and 0.174 respectively. These findings suggest that the variables included in the SKz_GRP, NKz_GRP, and Karaganda_GRP models have a stronger correlation and explain a larger proportion of the variation in the GRP compared to the Akmola_GRP and Almaty_GRP models. Next. In table 5 there are presented results for ANOVA for all seven models.

The analysis reveals that the p-values are statistically significant for several models. Specifically, model 4 Karaganda_GRP has a significant p-value of 0.006, model 7 SKz_GRP has a significant p-value of -0.005, model 2 Aktobe_GRP has a significant p-value of 0.018, and model 6 NKz_GRP has a significant p-value of 0.009. These p-values indicate that the variables included in these models significantly impact the Gross Regional Product (GRP) of the respective regions.

Table 5- Models'Anova

Model		Sum of Sq	Stnd.dev	Mean Sq	F	Sig.
1 Akmola_GRP	Regression	88461159194,981	1	88461159194,981	,211	,657[b]
	Residual	3777086314825,008	9	419676257202,779		
	Total	3865547474019,989	10			
2 Aktobe_GRP	Regression	2024719769292,232	1	2024719769292,232	8,275	,018[b]
	Residual	2202157907813,431	9	244684211979,270		
	Total	4226877677105,663	10			
3 Almaty_GRP	Regression	1848056639272,743	1	1848056639272,743	1,902	,201[b]
	Residual	8744869628453,944	9	971652180939,327		
	Total	10592926267726,688	10			
4 Karaganda_GRP	Regression	16068541353106,752	1	16068541353106,752	12,412	,006[b]
	Residual	11651654150240,850	9	1294628238915,650		
	Total	27720195503347,600	10			
5 Kostanay_GRP	Regression	1890166344728,796	1	1890166344728,796	4,128	,073[b]
	Residual	4120912408901,872	9	457879156544,652		
	Total	6011078753630,668	10			
6 NKz_GRP	Regression	804052211621,922	1	804052211621,922	11,015	,009[b]
	Residual	656939513058,807	9	72993279228,756		
	Total	1460991724680,729	10			
7 SKz_GRP	Regression	8056185779761,133	1	8056185779761,133	13,371	,005[b]
	Residual	5422483285138,199	9	602498142793,133		
	Total	13478669064899,332	10			

Note: compiled by the authors

Furthermore, the F-statistics, which measure the overall significance of the models, are relatively high for model 7 SKz_GRP (13.371), model 6 NKz_GRP (11.015), model 4 Karaganda_GRP (12.412), and model 2 Aktobe_GRP (8.275). These high F-statistics suggest that these models can explain a significant amount of the variation in the GRP of their respective regions.

Overall, the results indicate that the variables included in models 4, 7, 2, and 6 have a strong and significant influence on the GRP, as evidenced by their low p-values and high F-statistics. These findings provide valuable insights into the factors that contribute to the economic performance of Karaganda, SKz, Aktobe, and NKz regions, respectively.

The correlation-regression analysis revealed that the length of railway lines and roads significantly influences the Gross Regional Product (GRP) of specific regions. Models focusing on Karaganda, SKz, Aktobe, and NKz regions showed strong correlations, as indicated by their high R-squared values. These models also had low p-values and high F-statistics, indicating their statistical significance and ability to explain a significant portion of GRP variation. These findings highlight the importance of transportation infrastructure in regional economic performance.

From an economic perspective, the analysis reveals that the length of road infrastructure significantly impacts specific regions' Gross Regional Product (GRP). The significant p-values obtained for models 4 (Karaganda_GRP), 7 (SKz_GRP), 2 (Aktobe_GRP), and 6 (NKz_GRP) indicate that the inclusion of road length as an independent variable has a strong and significant influence on the economic performance of these regions. This suggests that the availability and quality of road infrastructure play a crucial role in driving economic growth and development.

Furthermore, the high F-statistics for models 7 (SKz_GRP), 6 (NKz_GRP), 4 (Karaganda_GRP), and 2 (Aktobe_GRP) indicate that these models can explain a significant amount of the variation in the GRP of their respective regions. This implies

that including road length as an independent variable in these models contributes to a better understanding of the factors that influence regional economic performance.

The correlation regression analysis further strengthens the significance of transportation infrastructure, as it reveals a strong correlation between the length of railway lines and roads and the GRP of specific regions. The high R-squared values in models focusing on Karaganda, SKz, Aktobe, and NKz regions indicate that a substantial portion of the variation in GRP can be explained by the length of transportation infrastructure.

Recent developments in the world have further emphasised the importance of transportation infrastructure. The COVID-19 pandemic has disrupted global supply chains and highlighted the need for resilient and efficient transportation networks. Investments in road infrastructure have become crucial for facilitating trade, ensuring the smooth flow of goods and services, and supporting economic recovery. Additionally, with the rise of e-commerce and the digital economy, reliable transportation infrastructure is essential for last-mile deliveries and connecting businesses to consumers.

The analysis underscores the significant influence of road length and transportation infrastructure on the economic performance of specific regions. These findings align with the broader understanding that well-developed transportation networks promote economic growth, attract investments, and foster regional integration. Policymakers and stakeholders should prioritize investments in transportation infrastructure to enhance regional economic performance and ensure sustainable development in light of recent global developments.

Conclusion

Logistics improvement in regions plays a critical role in determining the economic potential of different regions in Kazakhstan. Improved transportation infrastructure and connectivity can attract investment, promote trade, and facilitate economic growth and diversification. Therefore, policymakers in Kazakhstan should prioritize the development of transport infrastructure and connectivity to enhance regional accessibility and unlock the economic potential of the country's different regions.

The experience of developed countries highlights the importance of logistics in promoting regional accessibility and economic development. Improvements in logistics infrastructure, such as the development of intermodal transportation systems and logistics clusters, can enhance connectivity between regions, reduce transportation costs, and facilitate the movement of goods and services.

Kazakhstan has a well-developed railway infrastructure, with a total operational length of approximately 16,800 km as of 2021. The country's strategic location at the crossroads of major international transport corridors makes rail transport a vital component of its transportation infrastructure. The railway lines in Kazakhstan facilitate both domestic and international freight and passenger transportation.

Analyzing the data presented in the table, it is evident that the Karaganda, Aktobe, and Almaty regions have the most extended railway lines in terms of length. These regions have also experienced significant growth in their railway networks in recent years. However, regions such as West Kazakhstan, Kostanay, and Kyzylorda have comparatively fewer rail lines. Karaganda stands out with substantial growth in railway lines, while Kostanay and Akmola have shown a decline. When considering the overall development of railway infrastructure, it is essential to consider the ratio of railway line length to the region's area. For instance, the West Kazakhstan region has the highest ratio, indicating a relatively dense railway network. On the other hand, the Almaty region, despite having a shorter railway line length, plays a crucial role in providing a dense railway connection with neighboring countries and facilitating a significant portion of international freight traffic through Kazakhstan.

It should be noted that the development of the railway infrastructure varies across different regions of Kazakhstan. Additionally, the transportation of goods and services is influenced by various factors, such as road and air infrastructure, the presence of free trade zones, and more.

Examining the top three regions, namely Karaganda, Aktobe, and Almaty, it is clear that Karaganda has the most extended railway lines, and the highest traffic volume and significantly contributes to the country's GDP. Aktobe has a slightly shorter railway line length but still maintains substantial traffic volume. Its contribution to the GDP is relatively lower than in Karaganda. Almaty, while having a shorter railway line length and traffic volume than the other two regions, has experienced significant growth in railway lines.

Considering regions with indicators above the national average, the following regions remain Akmola, Almaty, Kostanay, Aktobe, Karaganda, and East Kazakhstan. Further analysis revealed that the length of roads in Kazakhstan had shown a heterogeneous change over the period from 2011 to 2021. While the overall trend indicates an increase in road length, some regions experienced a decrease. Akmola and Pavlodar regions demonstrated the highest growth in road length, while Atyrau and Zhambyl regions experienced significant reductions.

In summary, Kazakhstan possesses a well-developed railway infrastructure, but its level of development varies across different regions. The length of railway lines in Karaganda, Aktobe, and Almaty regions is noteworthy. Additionally, the length of roads in the country has generally increased, reflecting economic development and rising demand for transport services. However, specific regions may require additional investment in their transport infrastructure to meet the growing demand.

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