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**Transport Problems 2022**

UNDER THE HONORARY  
PATRONAGE OF



Silesian  
University  
of Technology



Krajowa  
Reprezentacja  
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CONFERENCE

XI INTERNATIONAL  
SYMPOSIUM OF YOUNG  
RESEARCHERS



Silesian University of Technology  
Faculty of Transport and Aviation Engineering

# Transport Problems 2022

## Proceedings

XIV International Scientific Conference

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## **ASSESSMENT OF LOGISTIC FACTORS AND FORECAST OF THEIR IMPACT ON ECONOMIC GROWTH: ON THE EXAMPLE OF KAZAKHSTAN**

**Summary.** It is important to form and determine the degree of influence of each factor of the logistics system on the forecast of economic development.

The article assesses the impact of the development of logistics systems on the efficiency of the functioning of the economy of Kazakhstan. As complex macroeconomic factors affecting the development of logistics and economic growth of the country and its individual regions, transport, investment, economic, information, material and technical, labor and infrastructure factors are considered.

Using models of regression and factor analysis according to statistical data for 2009-2020, the most important factors were identified and their relationship with the level and efficiency of logistics development was determined.

The analysis established the nature of the relationship between the logistics infrastructure and the regional economy, and also assessed the situation depending on these factors.

Based on the results of factor and index methods of analysis, mechanisms were developed for developing the main priorities of logistics systems that affect the efficiency of the country's economy, and directions for their further development were proposed. The forecast is based on the studied factors up to 2030.

To improve the efficiency of the functioning of the economy and improve the logistics components, recommendations were developed to improve the specified criteria for logistics services, as well as ways to improve the efficiency of the functioning of logistics links in these sectors of the economy.

The practical significance of the work lies in the fact that its results can be used as recommendations for long-term development.

## **ОЦЕНКА ЛОГИСТИЧЕСКИХ ФАКТОРОВ И ПРОГНОЗ ИХ ВЛИЯНИЯ НА ЭКОНОМИЧЕСКИЙ РОСТ: НА ПРИМЕРЕ КАЗАХСТАНА**

**Аннотация.** Важно сформировать и определить степень влияния каждого фактора логистической системы на прогноз развития экономики.

В статье проведена оценка влияния развития логистических систем на эффективность функционирования экономики Казахстана. В качестве комплексных макроэкономических факторов, влияющих на развитие логистики и экономический

рост страны и отдельных ее регионов, рассматриваются транспортный, инвестиционный, экономический, информационный, материально-технический, трудовой и инфраструктурный факторы.

Используя модели регрессионного и факторного анализа по статистическим данным за 2009-2020 гг., выявлены наиболее важные факторы и определена их взаимосвязь с уровнем и эффективностью развития логистики.

В ходе анализа установлен характер взаимосвязи между логистической инфраструктурой и региональной экономикой, а также проведена оценка ситуации в зависимости от указанных факторов.

По полученным результатам факторного и индексных методов анализа были разработаны механизмы разработки основных приоритетов логистических систем, влияющих на эффективность экономики страны, и предложены направления их дальнейшего развития. Прогноз основан на изученных факторах до 2030 года.

Для повышения эффективности функционирования экономики и улучшения логистических компонентов выработаны рекомендации по улучшению указанных критериев логистического обслуживания, а также пути повышения эффективности функционирования логистических звеньев в указанных отраслях экономики.

Практическая значимость работы состоит в том, что ее результаты могут быть использованы в качестве рекомендаций при долгосрочном развитии.

## 1. INTRODUCTION

Factors that determine the effectiveness of logistics systems (LS) are the driving forces for economic development and growth. Transport, investment, economic, information, logistics, labor and infrastructure factors are considered as complex factors in the study.

However, as the analysis shows, many issues of the development of logistics with the development of the transport complex are not linked to the development of the regional economy, are fragmented and are not associated with the spatial and territorial development of the country's regions. This, in our opinion, is primarily due to the lack of an adequate methodology for assessing the impact of factors on the economy of regions and the country as a whole.

Based on the analysis of foreign sources and summarizing various methodologies, we came to the conclusion that in different countries, logistics factors affect socio-economic development in different ways. This requires an individual approach when using certain methods and indicators for research.

The purpose of the study is to assess the factors affecting the efficiency of the functioning of logistics systems and economic growth.

The main difference of the study lies in the establishment of a group of factors affecting the country's economy as a whole and their combination in the schedule with regional logistics development indices, which gives a clear and complete picture of the impact of each logistics component on the development of the regional economy and on the country's economic growth.

## 2. LITERATURE REVIEW

The development of transport usually occurs in parallel with the growth of the economy, and the growth of the transport sector generates an increase in the share of employees and their incomes.

The harmonious development of the economy and logistics leads to sustainable economic growth only through more efficient use of logistics resources [1].

The relationship between regional logistics and the regional economy was determined by taking 20 key factors [2]. A study of the impact of investments on logistics showed a positive growth in exports in Spain [3], in particular, a 10% increase in capital increased regional exports by 4%.

Kai Hu et al [4] assessed the impact of logistics on regional GDP and investment in China. The paper [5] analyzed changes in the GDP structure of Lithuania and 28 EU countries in 2008-2012 and

found that the import of transport and logistics services will increase transport and logistics services by 59%.

Many countries are now increasing their investment in logistics, and it has become a rapidly growing segment for economic development [6]. The development of fixed capital in logistics leads to sustainable economic growth only through more efficient use of resources [1]. It has been established that the obsolescence and deterioration of the material and technical bases of logistics and the lack of personnel hinder the effective development of logistics [7, 8].

Through the use of advanced technologies such as computer networks, barcodes, and navigation systems, traditional logistics has evolved into a high-performance, high-tech, and high-content information industry [7]. Therefore, as information support factors, we took: the volume of communication services; mobile subscribers; people who use the internet.

In [9], a close relationship is established between economic development and logistics components such as: transportation, warehousing, processing, delivery and information technology. The degree of influence of the logistics infrastructure on the competitiveness and efficiency of the functioning of the economy was determined and studied in [10, 11]. It is determined that the main driving forces for the development of transport are industry, trade and agriculture.

C. Bensassi et al. [12] in their study studied the relationship of geographical and transport factors to the economy and found that the number, size and quality of logistics facilities have a positive impact on export flows.

A generalization of various areas for measuring and evaluating the logistics potential can be presented as an aggregate indicator that takes into account individual territorial correlation coefficients [13]: an assessment of the attractiveness of the economic and geographical location, an indicator of the transit potential of the territory, and an assessment of the efficiency of the transport and storage infrastructure.

The above authors point out that the relationship between regional logistics and economic growth is closely related. However, modern research focuses on the following aspects: empirical analysis of the logistics system and economic relations, many of which reflect the level of development of the logistics system and the economy, respectively, using general social logistics costs and GDP, for example, using one parameter to determine the development of logistics or economic development, the level is determined logistics development and economic development.

Thus, in our opinion, the calculation of the indicator of the development of transport and logistics potential should be either a multiplicative criterion or an index evaluation method.

Measuring the indicators and potential of the transport and logistics system becomes an argument for making decisions in the field of investing in regional infrastructure in terms of conducting an effective policy of socio-economic development.

### 3. METHODOLOGY

The following methodology is proposed for assessing the impact of transport and logistics systems on the economy of Kazakhstan, which consists of the following stages.

*At the first stage*, we single out the logistics factors that affect the economic growth and efficiency of the economy of Kazakhstan, from seven main groups of factors, according to pre-selected indicators based on factor regression analysis [14]. In particular, there are several key factors that affect logistics at the macroeconomic level: 1. factors of investment in logistics; 2. logistics of transport; 3. possibility and level of use of information technologies; 4. transportation factors, i.e. logistics factors; 5. economic factors; 6. human resources and personnel factors; and 7. infrastructure factors.

*At the second stage*, their effectiveness was determined by a standard discrete analysis of the 7th group of factors in Kazakhstan for the period from 2009 to 2020, the actual change in these categories was determined using a general annual comparison. The influence of each factor on GDP is determined on the basis of regression analysis.

*At the third stage*, with the aim of assessing the indicators of logistics development in the regions on the average for 2014-2020 and brought to the same level based on them based on linear scaling.

The interval is between 0; 1, that is, 1 is the maximum value, 0 is the minimum value. Data evaluation based on linear scaling was used to normalize the indicators according to the method [14], and the overall index Ilog was calculated using the formula (1.1)

$$I_i = \frac{(I_{current} - I_{min})}{(I_{max} - I_{min})}, \quad (1)$$

где,  $I_i$  - индекс specific considered economic or logistical indicator of the region;  $I_{current}$  – the initial value of the indicator for the analyzed region;

The effectiveness of the development of the logistics system and economic growth is determined by a comprehensive comparison of the interval of regional development and the border of the display range and is interpreted as follows: effective development ( $0.32 < I$ ); close to effective development ( $0.3 < I < 0.32$ ); development with signs of inefficiency ( $0.27 < I < 0.30$ ); inefficient development ( $I < 0.27$ ).

At the fourth stage, a regression analysis was carried out to assess the influence of individual factors on economic growth. To assess the influence of factors on economic growth, 20 variables were proposed, considered as independent variables.

At the fifth stage, a factor analysis was carried out based on the economic and mathematical model of the study in order to determine the sufficiency of variables and their division into specific groups.

At the sixth stage, on the basis of an expert questionnaire, strategic directions for the Republic of Kazakhstan were identified, a SWOT analysis was carried out on them, and ways for their further development were proposed.

All analyzes are performed in SPSS. Among the studied factors affecting economic growth are the main elements of the influence of the logistics macro- and regional environment (Table 1), where the variables for the country are used to assess the impact of factors on economic growth and forecast, and the variables for the regions are used to assess the level and effectiveness of logistics development.

Tab. 1

Factors affecting macro- and regional logistics systems

Macro environmental factors		
Category	Variables by Republic	Regional Variables
Economic factors	The volume of industrial production, (Industry), billion tenge (goods, services)	The volume of industrial production in the region, mln. tenge
	Gross output of agricultural products (services), (Agriculture), billion tenge	Gross output of agricultural products (services) in the region
	Trade turnover in tenge (export), Export, million dollars	Wholesale volume, million tenge
	Trade turnover in foreign currency (import), Import, million dollars	Retail trade volume, million tenge
Investment factors	Investments in fixed capital (Inv), billion tenge	Investments in fixed assets, in transport and warehousing by regions, million tenge.
	Investments in fixed capital at the expense of all sources of financing by types of transport (InvTr), billion, tenge	Availability of fixed assets at initial cost, million tenge.
	Fixed assets by transport enterprises (OS) billion tenge	Investments in fixed capital, million tenge
Transport factors	Transported (transported) cargo, luggage, cargo luggage (Tasymal/ Cargo transp.), million tons	The volume of postal and courier services, million tenge.
	Freight turnover (Turnover), billion t-km	Volume of freight traffic, thousand tons
	Gross output of transport services (Output tr.serv.), billion tenge	Freight turnover, million tkm
Material-technical support	Import of vehicles (ImportTr), thousand units	Investments in machinery, equipment, vehicles, tools and their overhaul
	Commissioning of the main production capacities of transport through the construction of new,	Commissioning and acquisition of new fixed assets



	expansion and reconstruction of existing enterprises (NewTr), million tenge	
	Availability of trucks owned by citizens, (Truck), thousand units	Availability of trucks, units
Human Resources and Personnel	Employed population in the transport industry, (Labor), thousand people	Number of enterprises
	Average monthly salary of employees of transport enterprises, (Salary), thousand tenge	Average monthly salary in transport and warehousing, tenge
	Number of transport enterprises, (Firm), units	Employed in the economy, total, units
Information technology factors	Volume of communication services, (Communication), billion tenge	The volume of communication services by regions, million tenge.
	Mobile cellular subscribers (per 100 people), Mobile	Share of households with access to the Internet, %
	Individuals using the Internet (% of the population), (Internet)	Number of fixed Internet subscribers, thousand units
Transport infrastructure factors	Railway network density, km/thousand km <sup>2</sup> (DReal)	Operating length of the railway network in the region, thousand km.
	Road density, km/thousand km <sup>2</sup> (Davto)	Length of motor roads in the context of regions, thousand km
	Inland waterways (operated), km (Diwatw)	Share of waterways in regions, %

#### 4. RESEARCH RESULT

##### 4.1 Analysis of the effectiveness of the use of the logistics component in the development of the economy

According to the second stage of the methodology, seven groups of factors were evaluated.

**Economic factors.** Between 2009 and 2020, the data for all four variables are positive, i.e. figures are growing every year.

We have analyzed the discrete logistics statistics of the real sector of the economy, where  $R^2 = 0.95$ , i.e. these variables affect about 95% of GDP,  $F_{value} < 0.0001$ , standardized coefficients Industry = 0.427, Agriculture = 0.564, Exports = -0.288, imports = 0.175, all but exports are positive, and deviations are negligible.

With an increase in the calculated GDP (Pred (GDP)) by one unit, the export variable decreases by -0.2102, and the other variables increase in parallel, industry by 1.815 units, agriculture by 4.288 units, import by 0.311 units (see Table 2). However, each year in 2009–2019, the standard deviations were significantly between -1 and 1. The largest negative deviation was in 2013, where the standard deviation was less than 0.891 units, and the maximum positive deviation in 2015 was greater than the standard deviation by 0.971 units (Fig. 1).

**Investment factors.** Between 2009 and 2020, the data for all two variables are positive, i.e. figures are growing every year. On the contrary, investments in fixed capital at the expense of all sources of financing of the falling variable mode of transport decreased only by 9.7%. From 625.666 billion tenge to 564.350 billion tenge.

We analyzed the discrete statistics of LS on investment income, where  $R^2 = 0.978$ , i.e. these variables affect approximately 97% of GDP,  $F_{value} < 0.0001$ , values of standardized coefficients  $\beta_{Inv} = 0.163$ ;  $\beta_{InvTr} = 0.056$ ;  $\beta_{OS} = 0.809$ , has a positive value and deviations are insignificant. With an increase in the estimated GDP (Pred GDP) by one unit, all variables increase in parallel, if investments in fixed assets increase by 1.1 units, investments in fixed assets from all sources of transport by mode of transport increase by 5.115 units, fixed assets of transport enterprises by 3.87 units (see Table 2).

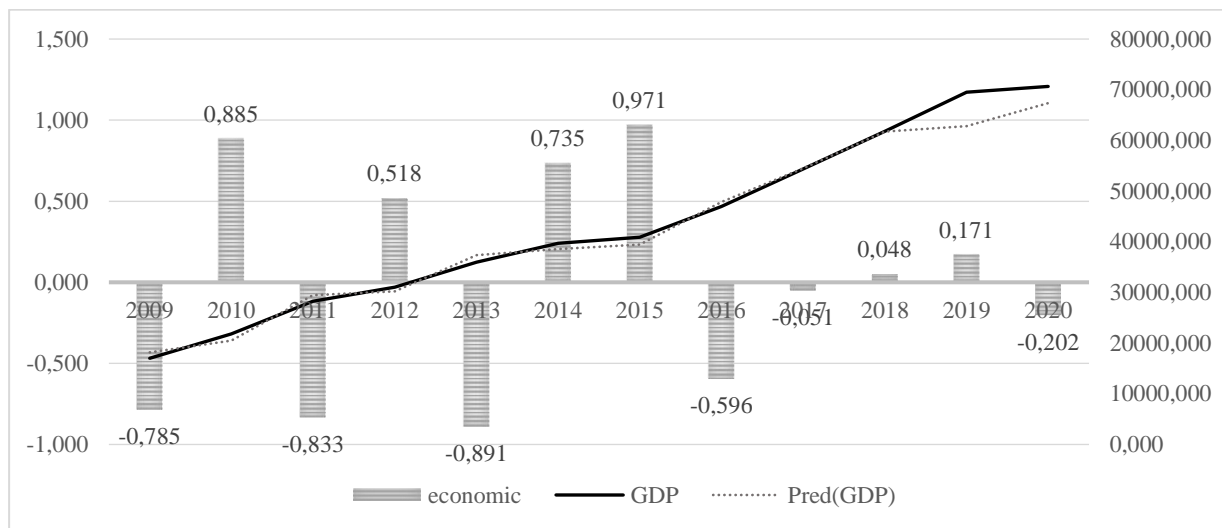


Fig. 1. Discrete statistical analysis of the factor of the real sector of the economy for the period 2009-2020

**Freight transport variables.** Transport is a factor that performs the main functions of the logistics system. Between 2009 and 2020, the data for all three variables are positive, i.e. figures are growing every year.

Discrete statistics analyzes have the following values, where the correlation has a value of  $R^2 = 0.95$ , i.e. these variables affect the formation of GDP by 95%, and the Student's value is less than 0.05, % (Pvalue = 0.0001). The values of cargo, freight turnover and total transport output are positive and less than 1 ( $\beta_{Tasymal}=0.491$ ,  $\beta_{Turnover}=0.609$ ,  $\beta_{OutputTr}=0.817$ ), which means that the deviation level is very low and negligible.

As Prev (GDP) grows, freight turnover will increase by 128.0 units, and transport output by 7.444 units, and traffic volume will increase by 1,048 units. (see table 2).

**Material-technical support factors (MTS).** Between 2009 and 2020, the data for all three variables differ. To analyze the impact of the relationship between GDP and economic growth, we also analyzed the logistics factor for discrete statistics, where the correlation has a value of  $R^2 = 0.70$ , i.e. these variables affect 70% of GDP, and Student's value is 0.05%, small (Pval=0.017), the report is built correctly according to the standard. In addition, the values of imports of vehicles, commissioning of the main production capacities of transport through the construction of new facilities, expansion and reconstruction of existing enterprises are negative, although less than -1. On the contrary, the value of the number of trucks owned by citizens is positive and less than 1 ( $\beta_{ImportTr}=-0.221$ ,  $\beta_{NewTr}=-0.029$ ,  $\beta_{Truck}=0.879$ ), which means that the level of deviation is very low and negligible. With an increase in Pre (GDP) by 1 unit, the variable of car imports will decrease by -37.836 units, the variable of input of the main production capacities of cars due to the construction of new capacities, expansion and restructuring of existing enterprises will decrease by -1.219 units. The number of vehicles increases by 683.5 units. (See Table 2).

**Human Resources and Personnel variables.** Between 2009 and 2020, data for all three variables were positive, i.e. The numbers have been growing every year. The population with the smallest increase in variable employment increased by only 1.1 units, from 7,903.4 thousand to 8,780.8 thousand people. The number of transport enterprises increased from 1119 units to 2092 units, an increase of 1.86 times. The average monthly salary of employees of transport enterprises, brought to the highest level, increased by about 2.5 times (Table 10).

The analysis of discrete statistics of LS on labor resources was carried out, where  $R^2 = 0.96$ , i.e. these variables affect approximately 96% of GDP, the value of  $F < 0.0001$ , the values of the standardized coefficients  $\beta_{Labor}=-0.094$ ,  $\beta_{Salary}=0.804$ ,  $\beta_{Firm}=0.278$ . The employed population is negative, but not less than -1. The other two variables are positive and the deviations are insignificant. (See Table 2).

As the estimated GDP (Pred (GDP)) increases by one unit, the employed population variable decreases by -29.28, the remaining wage increases by 321.9 units, and the number of firms increases by 13.08 units.

**Variables on the use of information technology.** The number of mobile communication subscribers with the least change varied from 106,359 units per hundred to 138,582 units, an increase of 1.3 times. The volume of additional communication services amounted to UAH 438.4 billion. 854.6 billion tenge. tenge and almost doubled. The number of people using the Internet increased from 18.2% to 81.9%, more than quadrupling.

The discrete statistics of LS on information support is as follows, where  $R^2 = 0.864$ , i.e. these variables affect about 86% of GDP,  $F < 0.0001$  value, standardized coefficients: communication = 1.313, mobile communication = -0.149, Internet = - 0.29, except for communication, all have a negative value, but the deviations are insignificant, since they do not exceed - one.

If the calculated GDP (Pred (GDP)) increases by one unit, then the communication variable will increase by 91.05 units, mobile communication will decrease by -164.0 units, the Internet will increase by 247.48 units (see Table 2).

**Transport infrastructure variables.** The density of the rail and road networks is directly proportional to economic growth, while the density of inland waterways is inversely related (see Table 2).

As a result, we can say that the development of the logistics sector in the country is one of the most important factors determining economic growth. Thus, the implementation of the state policy to encourage investment in this area will have a positive impact on economic growth. For example, the services provided by the transport infrastructure, which is an important aspect of the logistics sector, play an important role in a country's economic activity. While investment in this area reduces transport costs, it facilitates trade by increasing the mobility of goods and services. Similarly, changes in telecommunications will facilitate search, information services, human resources, logistics, advertising, sales, orders, and transportation.

The quality of the constructed regression models for each of the 22 considered main indicators was assessed using the following criteria: 2) Fisher-Snedekor F-test ( $R_{nab1}$ ); 3) Student's t-test; 4) multiple coefficient of determination ( $R^2$ ); 5) Beta coefficients ( $\beta_i$ ) or standardized regression coefficients.

This study showed that there is a strong relationship between logistics variables and economic growth, and that this has a direct impact on economic growth. First, we used a dynamic structural model for the six obtained factors: transport, investment income, logistics, real sector of the economy, human resources, information support. By using a dynamic structural model, we can observe how relationships change over time and make more accurate estimates. Therefore, it can be assumed that the above factors in the country have a significant impact on the development of the climate industry and accelerate growth and development, providing significant competitive advantages.

From the point of view of conducting an effective policy of socio-economic development, the assessment of the efficiency and capacity of the logistics system is evidence of decision-making both at the macro level and at the micro level. Since, today, the creation of logistics centers on the basis of public-private partnerships requires investments not only in terms of financial and economic analysis, but also in terms of describing the growth potential of the logistics system and management efficiency.

Thus, when calculating the development of the logistics system, it is necessary to use either a multiplicative criterion or an index criterion. The multiplicative test is best used at the macro level, but the index test is best used at the regional level.

#### **4.2 Index analysis of logistics systems at the regional level and its impact on the efficiency of the national economy**

Taking into account the analysis of existing methods for assessing the development of the logistics potential of the region, a comparative assessment of all regions of Kazakhstan was made on the basis of the economic indicators of the region and the indicators of the logistics system. The development of the logistics potential of the region was assessed using formula 1.1 based on the economic indicators of the region and the indicators of the logistics system [14].

Tab. 2

Regression statistical analysis of the influence of factors on the development of the economy

<b>dependent variable GDP</b>	$GDP = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7$				
Independent variables:	coefficient	std error	t-stat	$\beta$ -коэфф.	prob
<b>1) Economic variables: R<sup>2</sup>=0.9904; F=181.2</b>					
<i>Industry</i>	1.8154***	0.322	5.637	0.427	0.0007
<i>Agriculture</i>	4.2887**	1.208	3.550	0.564	0.0380
<i>Export</i>	-0.2102**	-0.077	2.729	-0.288	0.0299
<i>Import</i>	0.3114*	0.133	2.324	0.175	0.0566
<i>b<sub>0</sub></i>	81.6577	52.244	1.563		0.9825
<b>2) Variable investments: R<sup>2</sup>=0.9859; F=186.5</b>					
<i>Inv</i>	1.100***	0.163	6.748	0.163	0.0030
<i>InvTr</i>	5.115***	0.056	91.339	0.056	0.0054
<i>OS</i>	3.8712***	0.809	4.258	0.809	0.0096
<i>b<sub>0</sub></i>	2476.941	291.925	8.488		0.8934
<b>3) Transportation variables: R<sup>2</sup>=0.9510; F=51.8</b>					
<i>tasymal/cargo transps</i>	1.048***	0.049	3.482	0.491	0.0030
<i>Turnover</i>	128.035**	56.778	2.255	0.609	0.0281
<i>OutputTr</i>	7.444***	1.620	4.594	0.817	0.0017
<i>b<sub>0</sub></i>	-6141,634	128.423	47.823		0.000
<b>4) Material-technical support variables: R<sup>2</sup>=0.8857; F=30.6</b>					
<i>ImportTr</i>	-37.836*	-17.461	2.167	-0.221	0.0553
<i>NewTr</i>	- 1.219*	-0.525	2.321	-0.029	0.0492
<i>Truck</i>	683.583***	99.457	6.8731	0.879	0.0001
<i>b<sub>0</sub></i>	-136781.362***	524,241	260.913		
<b>5) Human Resources and Personnel variables: R<sup>2</sup>=0.8858; F=185.2</b>					
<i>Labor</i>	-29.2811**	-10.017	2.923	-0.094	0.0305
<i>Salary</i>	321.9038***	64.349	5.0024	0.804	0.0010
<i>Firm</i>	13.0280*	4.634	2.8112	0.278	0.0672
<i>b<sub>0</sub></i>	73319.411	1114.54	65.784		
<b>6) Variables on the use of information technology: R<sup>2</sup>=0.9723; F=93.8</b>					
<i>Communication</i>	91.0547***	23.546	3.867	1.313	0.0070
<i>Mobile</i>	-164.0071**	-57.973	2.829	-0.149	0.0324
<i>Internet</i>	247.4811***	8.916	27.754	0.290	0.0025
<i>b<sub>0</sub></i>	-40689.2661	285.825	142.357		
<b>7) Transport infrastructure variables: R<sup>2</sup>=0.9301; F=35.9</b>					
<i>DReal</i>	86975.188***	9751.764	8.9189	0.899	0.0001
<i>Davto</i>	432.204**	192.224	2.2551	0.015	0.0488
<i>Diwatw</i>	-48650.983*	32051.49	-1.5179	-0.157	0.1675
<i>b<sub>0</sub></i>	-383786.259***	116643.84	-3.290		0.0110

Note: Significance level \*p &lt; 0.05, \*\*p &lt; 0.01, \*\*\*p &lt; 0.001

All regions of Kazakhstan were developed based on the criteria in Table 3, divided into four groups.

The regions with the highest scores for all criteria are Almaty (0.38), Almaty (0.37), Mangistau (0.34), Akmola (0.32) and Pavlodar (0.32).

Weak development and the lowest indicators of logistics are in Atyrau (0.26), East Kazakhstan (0.26) and Zhambyl (0.24) regions, satisfactory in terms of economic indicators (0.13 and 0.13) and very low in terms of logistics indicators (0.10 and 0.10). Akmola (0.15), West Kazakhstan (0.13) and Mangystau (0.16) regions are at a satisfactory level in all indicators.

As can be seen from Table 3, the possibilities of the logistics potential of the regions of Kazakhstan are different. Export-raw material regions have a higher potential than agro-industrial zones.

For example, the highest level of logistics potential is in the Almaty region, Mangystau region, Almaty, Akmola region, Pavlodar region. In addition, the development of logistics potential is close to

effective: Aktobe region, Nur-Sultan city, Turkestan region and West Kazakhstan region. The lowest level of logistics potential is in Atyrau, East Kazakhstan and Zhambyl regions. However, in other areas, the logistical potential is moderate (Table 3).

Tab. 3

## Regional results in terms of logistics development indicators

Rank	Regions	index	Categories of LS index
1	Almaty	0.38	High pace and effective LS development
2	Almaty city	0.37	
2	Mangystau	0.35	
3	Pavlodar	0.33	
3	Akmola	0.32	
4	Aktobe	0.31	The level of development is close to effective or average
4	Nur-Sultan	0.31	
4	Turkestan	0.31	
5	West Kazakhstan	0.30	Average level of development or satisfactory development
6	Kustanai	0.29	
6	Kyzylorda	0.29	
6	East Kazakhstan	0.29	
7	Karaganda	0.27	LS is ineffective or very poorly developed
8	Atyrau	0.26	
8	North Kazakhstan	0.26	
9	Zhambyl	0.24	

A comparative analysis of individual indicators allows us to conclude that the growth rates of investment and logistics are high, evenly distributed across regions, but in economically underdeveloped regions, the logistics potential of these indicators is low.

#### 4.3. Formation of logistical factors affecting the efficiency of the functioning of the economy of Kazakhstan

Analyzing the studies of other authors, we have formed 22 macroeconomic indicators of Kazakhstan. Of these, gross domestic product (GDP) is an indicator, and the remaining 21 indicators are independent variables and conducted a factor analysis.

As a result of the study, we focused on the following issues: correlation matrix of variables; Kaiser-Meyer-Olkin results; internal significance of factors; factorial model, factors after varimax rotation.

The first results show the summary statistics of the correlation matrix between the selected variables. The closer the coefficients are to the coefficient |1|, the closer the linear dependence. OS was excluded from the next factor analysis due to the high correlation value (0.71).

According to the results of factor analysis, the following results were obtained: Cronbach's alpha - 0.725, the reliability of these results is evidenced by the ratio of the actual score and the total score (error plus actual score), which determined that the selected variables are acceptable [15]. The Kaiser-Meier-Olkin (KMO) index indicates the adequacy of the sample. The KMO in our model was 0.733, which means a satisfactory sample value [16].

Table 4 shows the eigenvalues obtained as a result of factor analysis analyzed for 20 variables for 2009-2020, as a result of which we identified 9 factor groups. In the factorial analysis of the correlation matrix, factor groups were selected in which the variables have a variance of more than 1 for each variable and have a scale of more than 1. Thus, 2 groups of factors were selected, and for these 2 groups of factors, you can see a high percentage of variability in the primary data of 91.53%.

The eigenvalue of the factors in the first factorial group was 8.856, its percentage variability was 73.8%, i.e. the influence of variables within this factor group is high. Then the value of the second group of factors fell sharply to 2.127, and its variability was 17.73%. That is, we proved that the variables within these two factor groups were 91.53% of 100% and in general had all the calculated effects, the influence of the remaining factor groups is very low or does not change. The structure of

the factorial group - variables after rotation using the Varimax method and the control coordinates are shown in the following table 5.

Tab. 4

Specific values of factor groups for 20 variables for 2009-2020

Factor group	1	2	3	4	5	6	7	8	9
eigenvalue	<b>8.856</b>	<b>2.127</b>	0.44	0.301	0.157	0.075	0.027	0.015	0.001
Share of variables (%)	73.801	17.729	3.666	2.507	1.312	0.626	0.223	0.124	0.012
Cumulative amount (%)	73.801	91.53	95.197	97.704	9.016	99.642	99.864	99.988	100.0

Tab. 5

Factor group model in the country after varimax rotation

Variables	Factor group 1	Factor group 2
Investments in fixed capital from all sources of financing by means of transport	-0.073	<b>0.089</b>
Investments in fixed assets	<b>0.319</b>	-0.098
Import of vehicles	0.033	<b>-0.210</b>
Availability of trucks owned by citizens	<b>0.053</b>	0.050
Carried cargo, hand luggage	0.038	<b>0.054</b>
Cargo turnover	<b>0.090</b>	-0.076
Average monthly salary of employees of transport enterprises	<b>0.086</b>	-0.065
Number of transport companies	0.003	<b>0.064</b>
Volume of industrial production (goods, services)	<b>0.082</b>	-0.046
Gross output of agricultural products (services)	0.053	<b>0.053</b>
Scope of communication services	<b>0.307</b>	-0.067
Mobile subscribers	0.044	<b>0.067</b>
Railway network density	<b>0.079</b>	-0.025
Road density	<b>0.089</b>	-0.040
Inland waterways	0,024	<b>-0,664</b>

As shown in Table 5, the maximum value is chosen in absolute terms to determine the components of each factor. For example, 0.089 is the absolute highest number for the fixed investment variable of all funding sources for two modes of transport, so we chose this variable. Thus, we have chosen two important groups of factors, and they are as follows (Table 6).

After identifying the two main groups of factors, we conducted a regression analysis. GDP was taken as dependent variable and other variables as independent variables:

$$\text{Модель 1(BBП)} = \beta_0 + \beta_{1inv} + \beta_{2Truck} + \beta_{3Salary} + \beta_{4Turnover} + \beta_{5Industry} + \beta_{6Communication} + \beta_{7DReal} \quad (2)$$

$$\text{Модель 2(BBП)} = \beta_0 + \beta_{1InvTr} + \beta_{2ImportTr} + \beta_{3Firm} + \beta_{4Agriculture} + \beta_{5Tasymal} + \beta_{6Mobile} + \beta_{7Davto} \quad (3)$$

The results of the ANOVA test showed a very high correlation between factors and GDP models (Tables 7 and 8). Model (2) shows (Table 7) that with an increase in GDP by one unit, investments in fixed assets increase by 2.558 units. ( $\beta_{Inv} = 0.418$ ), competitive industrial output by 0.313 units. ( $\beta = 0.305$ ), communication services by 73.3 units. ( $\beta = 0.586$ ), freight turnover 8.214 units. ( $\beta = 0.139$ ), the average monthly salary of employees of transport enterprises will increase in a positive proportion to 45.429 units. ( $\beta = 0.110$ ). However, the number of trucks owned by citizens decreases inversely by -79,237 units ( $\beta = -0.104$ ). In addition,  $R^2 = 0.997$ , i.e. these variables affect about 99% of GDP, F value = 0.001.

Model (3) shows (Table 8) that the R-squared values (97%) are very high. In all three samples, the F value was 0.05 or 5% lower, and the F-Stat values were significantly higher, which means that they are statistically significant and show an econometrically correct model from the Student and Fisher

tests. As can be seen from Table 8, with an increase in GDP per unit, the import of vehicles increases by 12.203 units ( $\beta_{\text{ImportTr}} = 0.056$ ), the total output of agricultural products (services) is 7.04 units ( $\beta = 0.541$ ). The number of mobile communication subscribers will increase by 130.93 units ( $\beta = 0.159$ ), the number of transport enterprises will increase by 1.94 units. ( $\beta = 0.042$ ). The volume of transported goods, luggage, hand luggage will increase by 14.9 units ( $\beta=0.528$ ).

Tab. 6

Factors affecting the effective functioning of the logistics system in the Republic of Kazakhstan

Group of factors	Variables	Factor group 1	Factor group 2
Economic factors	Industry	Industry	Agriculture
	Agriculture		
	Export		
	Import		
Investment factors	Inv	Inv	InvTr
	InvTr		
	OS		
Transport factors	Cargo transp	Turnover	Cargo transp
	Turnover		
	Output tr.serv		
Material-technical support	ImportTr	Truck	ImportTr
	NewTr		
	Truck		
Human resources and personnel	Labor	Salary	Firm
	Salary		
	Firm		
Information technology factors	Communication	Communication	Mobile
	Mobile		
	Internet		
Transport infrastructure factors	DReal	DReal	Davto
	Davto		
	Diwatw		

Tab. 7

Regression analysis of the influence of factors on economic growth after factor analysis according to the model (2)

Dependent variable-GDP	Модель 1(BBII) = $\beta_0 + \beta_{1inv} + \beta_{2Truck} + \beta_{3Salary} + \beta_{4Turnover} + \beta_{5Industry} + \beta_{6Communication} + \beta_{7DReal}$				
Independent variables	coefficient	std error	Beta coefficient	t-stat	significance
$\beta_0$	-102150,762	17727.404		-5.762	0.005
$\beta_{1inv}$	2.558	0.385	0.418	6.645	0.003
$\beta_{2Truck}$	-79.237	28.750	-0.104	-2.756	0.054
$\beta_{3Salary}$	45.429	18.889	0.110	2.405	0.502
$\beta_{4Turnover}$	8.214	4.144	0.139	1.982	0.038
$\beta_{5Industry}$	0.313	0.105	0.032	2.953	0.050
$\beta_{6Communication}$	73.319	21.078	0.586	3.479	0.025
$\beta_{7DReal}$	17492.231	3346.008	0.169	5.228	0.006
F stat	149.44	$R^2$		0.997	
Durbin-Watson	2.642	P-value		0.001	

However, investments in fixed assets from all modes of transport by modes of transport decreased by -4.844 units. ( $\beta_{\text{InvTr}} = -0.096$ ).

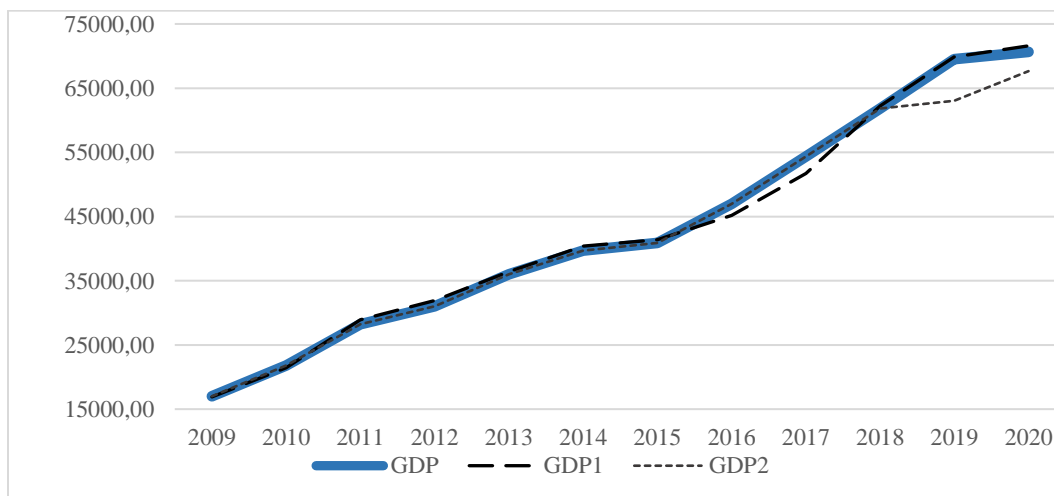
Tab. 8

Regression analysis of the influence of factors on economic growth after factor analysis according to the model (3)

Dependent variable- GDP	<i>Модель 2(BBII) = <math>\beta_0 + \beta_1 \text{InvTr} + \beta_2 \text{ImportTr} + \beta_3 \text{Firm} + \beta_4 \text{Agriculture} + \beta_5 \text{Tasymal} + \beta_6 \text{Mobile} + \beta_7 \text{Davto}</math></i>				
<i>Independent variables</i>	<i>coefficient</i>	<i>std error</i>	<i>Beta coefficient</i>	<i>t-stat</i>	<i>significance</i>
$\beta_0$	63025.233	87026.741		0.724	0.509
$\beta_1 \text{InvTr}$	-4.844	1.789	-0.039	-2.707	0.530
$\beta_2 \text{ImportTr}$	12.203	2.542	0.056	4.799	0.048
$\beta_3 \text{Tasymal}$	14.190	6.295	0,528	2.254	0.032
$\beta_4 \text{Firm}$	1.948	1.041	0.042	1.871	0.408
$\beta_5 \text{Agriculture}$	7.046	2.250	0.541	3.132	0.035
$\beta_6 \text{Mobile}$	130.937	22.478	0.159	5.825	0.062
$\beta_7 \text{Davto}$	2230.175	1136.105	-0.079	1.963	0.209
F stat	41.998			$R^2$	0.971
Durbin-Watson	1.824			$P\text{-value}$	0.010

On Fig. 2 shows a summary diagram of models (2) and (3) resulting from this factor analysis. It can be seen here that the deviation of the 1st group of factors from total GDP1 to real GDP is very small. Only the latest 2018-2020 years show a slight deviation. At the same time, although the diagram of factor group 2 has some deviations, it has changed little from changes in real GDP. This is due to the fact that the influence of the first group of factors on GDP is 73.8%. and the second factorial group is only 17.7%. The sum of the two groups of factors is 91.5%, and it is found that the variables belonging to this group of factors have a high impact on GDP. Therefore, using the data of these two factor groups, it is possible to predict the future. F1 group factors show a rather high impact on logistics and economic growth ( $\beta = 0.851$ ). This means that the growth of industrial production, freight turnover indicators, the volume of communication services, the density and quality of the railway network, investments in the fixed capital of the economy have a positive effect on the growth of logistics and the GDP of the Republic of Kazakhstan.

The influence of the group of factors (F2) is less significant ( $\beta = 0.149$ ). The priority factor is an increase in investment in the transport industry, an increase in the volume of agricultural products, the volume of communication services, and the density of automobile networks.



\*GDP - real GDP for 2009-2020.

\*\*GDP1 - GDP obtained as a result of using indicators according to the formula (2) of the 1st factor group 1

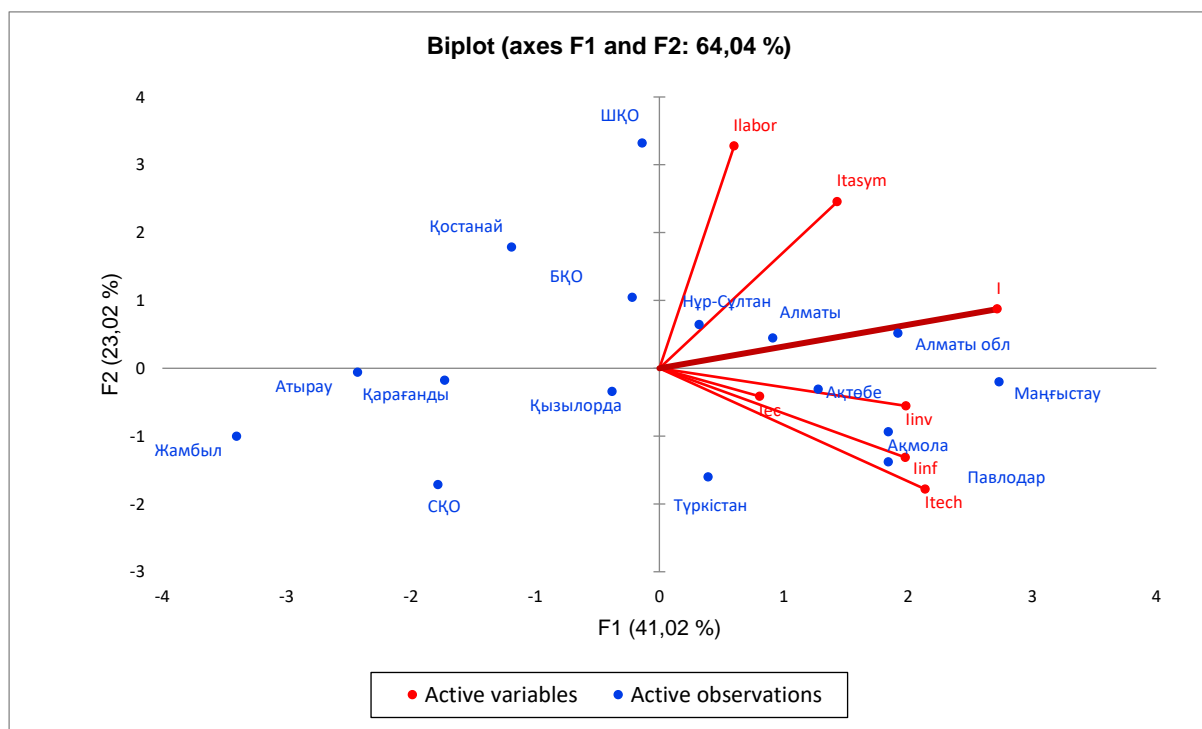
\*\*\*GDP2 - GNP formed as a result of using the indicators of the applied formula (3) of the 2nd factor group 2

Fig. 2. Diagram comparing GDP1 and GDP2 with real GDP, formed as a result of factor analysis using formulas (2) and (3)



In other words, the high level of investment in fixed capital in these regions does not require the allocation of funds from the state budget, i.e. the chances of attracting private and foreign investment in these regions are very high. Because the factors affecting the efficiency of the economy; freight turnover, the average monthly wage of transport workers, the volume of industrial production (goods, services), the volume of communication services have a high impact on economic growth.

It is necessary to introduce a comprehensive program for the development of logistics in the regions included in this group, and plan to increase the following indicators: an increase in agricultural production, an increase in the number of mobile subscribers, an increase in investment in fixed assets from all sources of financing through transport, freight, luggage. , increase the number of freight and transport enterprises. These regions have good chances to solve these problems at their own expense.



\* WKO-West-Kazakhstan, North Kazakhstan - North-Kazakhstan region, East-East-Kazakhstan region

\*\* IEC-Real sector of the economy, labor-Labor resources, Iinv-Income from investments, Itasim-Transport, Itech-Logistics, Iinform-Information support, I-Consolidated index

\*\*\* F1 and F2 - index diagrams of variables of the first and second factorial groups.

Fig. 3. Chart of factor groups 1 and 2 and regional indices for Kazakhstan

Group 2 - the level of development or medium development zones close to the effective LS, which affects economic growth. It is closest to the aggregated indicator and has a positive value in two factor groups - Nur-Sultan, logistics, investment income, real sectors of the economy and information support, positive in the first factor group, negative in the second factor group - Aktobe region. This group includes East Kazakhstan and West Kazakhstan regions, although the second group of factors is positive, and the first group of factors is negative.

For the second group, the improvement of the logistics systems of the region should be taken into account in the programs of projects of national importance with the participation of the state in financing and design.

Here it is necessary to create measures to increase the F2 coefficients in WKO and East Kazakhstan regions. Here, at the regional and republican levels, investments in transport infrastructure under programs, imports of vehicles, and an increase in freight traffic have increased the number of transport enterprises. All this is directly related to the increase in agricultural, commercial and industrial production.

And vice versa, the factors included in the F1 group: investments in fixed capital, the availability of trucks in the ownership of citizens, trade turnover, the average monthly salary of transport workers, the volume of industrial production (goods, services), the volume of communication services - are steadily developing. and do not require additional measures.

The main sources of financing for improving these indicators are the budget, extra-budgetary funds, enterprise funds and private funds.

Group 3 - the average level of development of LS or satisfactory development. Kostanay region is positive in the second factor group, and negative in the first factor group, Turkestan region, on the contrary, is positive in the first factor group, and the second factor group is negative. In addition, Kyzylorda and Karaganda regions have negative values in both factor groups.

For the third group of regions, the program is based on benefits provided at the facilities of logistics services and other state support. At the national level, the infrastructure development master plan should be developed taking into account the factors affecting these regions.

Group 4 - ineffective level of development or very poor development. These include Atyrau, North Kazakhstan and Zhambyl regions (Fig. 3). These are areas with low investment attractiveness and low need for infrastructure development.

For the period from 2021 to 2030, we made a forecast using statistical methods, using time series, using real GDP data for 1991-2020. As forecast variables for the group of factors F1, investments in fixed capital, the number of trucks owned by citizens, trade turnover, the average monthly salary of employees of transport enterprises, the volume of industrial production, and the volume of communication services were used. As can be seen from Table 9, the value of F1 increases by an average of 5.0% per year and has a positive value. The total value of F2 also increases from year to year and has a positive value with an average growth rate of 2.6%.

If we look at the group of forecast factors in Table 9, real GDP is projected at 2% annually compared to the previous year (2022-2030), only in 2021 is expected to grow by 3% compared to 2020. The influence of F1 factors on the economy averages 85%, and the factors of the F2 group have a low influence -15%.

## 5. DISCUSSION

The analysis of factors influencing macro- and regional logistics systems according to the proposed methodological approach allows us to determine the degree of influence of each factor on the economy and determine the level of development of logistics in each region of the country.

The study showed that there is a strong relationship between the components of the logistics system and economic growth, and that this has a direct impact on economic growth.

Based on the index method, the level of development and efficiency of logistics in the regions was identified, which made it possible to build an index map of the efficiency of regional logistics systems in Kazakhstan.

The dependence and degree of influence of each factor on GDP is determined.

On the basis of factor analysis using 20 variables, two groups of factors were identified that have a high degree (91.5%) influencing GDP. Similar studies carried out in [4, 9] and the resulting groups of factors are infrastructural factors. economic factors are consistent with our research.

The identified most characteristic factors in the development of logistics infrastructure that have an impact on economic growth in Kazakhstan make it possible to obtain the following benefits for the country: increased competitiveness; development of the commodity distribution services market in the region; optimization of the commodity distribution network in the regions; development of growth poles of the regional economy in [3, 10, 12, 16]. The conclusions obtained in our study once again confirms the consideration of these factors and a differentiated approach to the development of regions.

Tab. 9

Forecast of GDP, F1 and F2 for the Republic of Kazakhstan for 2020-2030

years	forecast (GDP), billion tenge	F1, billion tenge	F2, billion tenge	Annual GDP growth rate%	Annual growth rate F1%	Annual growth rate F2%
2020	70 649	71 592	67 648	-	-	-
2021	72 442	71 950.6	68 508	2.54	0.50	1.27
2022	74 222,7	76 258.2	72 376.5	2.46	5.99	5.65
2023	76 003	80 565.8	74 244.5	2.40	5.65	2.58
2024	77 783	84 873.3	76 112.6	2.34	5.35	2.52
2025	79 563.5	89 180,9	79 980.7	2.29	5.08	5.08
2026	81 343.8	93 488.5	80 848.7	2.24	4.83	1.09
2027	83 124.1	97 796.1	81 716.8	2.19	4.61	1.07
2028	84 904.4	102 103.6	83 584.8	2.14	4.40	2.29
2029	86 684.6	106 411.2	85 452.9	2.10	4.22	2.23
2030	88 464.9	110 718.8	87 320.9	2.05	4.05	2.19

We have established that the increase in production, investment in fixed assets; increase in fixed assets for transport enterprises; an increase in freight turnover and the production of transport services, an increase in the availability of freight vehicles, an increase in the volume of communication services provided, and the density of railway and road networks lead to positive economic growth.

These groups of factors provide a GDP development forecast of just over 2.0% annually compared to previous years (2009-2021), where growth due to these factors is less than 2.0%. It has been established that the influence of F1 factors on the economy is on average 5% more than the F2 group.

If we look at the group of forecast factors (Table 9), real GDP is projected at 2% annually compared to the previous year (2022-2030), only in 2021 is expected to grow by 3% compared to 2020. The influence of F1 factors on the economy averages 5%, and the factors of the F2 group have a lower impact - 3%.

That is, when compiling a program for the development of the regional economy, it is necessary to pay more attention to factors F1, compared to F2.

These factors F1 have a more positive effect on economic growth and increasing the competitiveness of the logistics services market, which must be taken into account when drawing up a program for the development of the territory.

For the effective functioning of the transport and logistics system, it is necessary: to increase the capacity and improve the quality of transport links and networks; formation of the infrastructural basis of a modern intermodal transport and logistics system in Kazakhstan; optimization of cargo flows, as well as reduction of the operational and infrastructure component of the cost of transportation; ensuring the growth rate of investments in fixed capital "transport and warehousing" at least 15% per year; infrastructure support for the growth rate of the gross regional product in the regions at a level of at least 8-10% per year;

For the development of LS in the Republic of Kazakhstan at different levels of economic management (enterprises, industry, region, national economy), the following organizational and economic mechanisms should be developed. First of all, this is the introduction of strategic management tools, that is, the planning of logistics processes. Secondly, the use of organizational, economic and financial mechanisms to stimulate the development of logistics and the introduction of modern logistics technologies, improve logistics processes and solve the logistics problems of economic growth. Thirdly, it is the active participation of the state in the regulation of logistics processes. One such means is the use of a concession mechanism for financing toll roads.

The solution to these problems is also the construction of new (in large centers of macroregions) and the improvement of the economic mechanism for the functioning of existing logistics infrastructures for each selected region, taking into account the prospective need and attractiveness in the movement of goods, as well as the development of support measures from the state, business and society for the development of logistics infrastructure in the specified regions.

## 6. CONCLUSION

The analysis of the factors influencing the macro- and regional logistics systems according to the proposed methodological approach, which allows us to determine.

To determine the impact of the development of transport and logistics systems on the development of the economy, we have identified a complex of factors. The considered factors have a positive effect on economic growth and the efficiency of regional development, which must be taken into account when drawing up a program for the development of territories.

In order to improve the development of logistics systems to improve the efficiency of the economy of Kazakhstan, an analysis of the current state and foreign experience in the development of LS was carried out, an assessment of the effectiveness of logistics development based on regression and factor analysis and an assessment of regional indicators made it possible to determine the current level of development of domestic LS. In this study, using economic and mathematical methods, it has been established that the restoration and development of LS is impossible without optimal state regulation.

On the basis of factor and index analysis, mechanisms were developed for developing the main priorities of logistics systems that affect the efficiency of the country's economy, and directions for their further development were proposed. The forecast is based on the studied factors up to 2030.

The analysis carried out confirms the need to include in the regional policy the development of the transport and logistics infrastructure of the regions as an important factor in their socio-economic development, increasing competitiveness and reducing costs by optimizing commodity distribution networks.

The following measures to improve the transport infrastructure, which have the greatest impact on the economy, are important for Kazakhstan: renewal and increase in the efficiency of the use of fixed assets; construction and creation of high-speed roads and high-speed railways connecting large regions in the most populated parts of the country and serving export-transit cargo flows; multimodal transport and logistics centers, digitalization of the industry.

All this will allow the transport and logistics industry to give momentum to reduce costs, increase the competitiveness of the national economy, improve the quality of service and increase the contribution of logistics to the economy.

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