TRANSPORT PROBLEMS 2022 Volume 17 Issue 4
PROBLEMY TRANSPORTU DOI: 10.20858/tp.2022.17.4.04

Keywords: logistics system; economic development factors; logistics development forecast; economic growth; factorial and regression analysis

Zhanarys RAIMBEKOV[1], Kunduz SHARIPBEKOVA[2], Bakyt SYZDYKBAYEVA[3], Ardak TURGINBAYEVA[4], Aleksander SLADKOWSKI[5]*

ASSESSING LOGISTIC FACTORS AND FORECASTING THEIR IMPACT ON ECONOMIC GROWTH: THE EXAMPLE OF KAZAKHSTAN

Summary. This article assesses the impact of the development of logistics systems (LS) on the efficiency of the economy. A multi-level methodology for assessing the impact of LS on the economy consisting of six stages (transport, investment, economic, information, material and technical, labor and infrastructure) is proposed using a dynamic structural model for a group of macroeconomic logistical factors for the period 2009–2020 for the republic and the regions of Kazakhstan. Their close relationship with economic growth has been established. Based on the results of factorial and index methods of analysis, mechanisms of differentiation in the management of the regional economy are proposed based on the level of development of logistics and their impact on the growth of the regional economy. Four groups of regions are identified according to the level of development of logistics and their impact on the economy, and directions for their further development are proposed. The forecast is based on the studied factors up to 2030. In particular, it has been established that for the long-term development of the economy of Kazakhstan, the development of agriculture and industry, investment in fixed assets, freight turnover, the availability of vehicles, wages, communication services, and the density of the railway network are important factors.

1. INTRODUCTION

Efficient LS is the driving force for economic growth and development. At the same time, the strength of the impact of logistical factors on the economy depends on the level of development of the constituent components. Transport, investment, economic, information, logistics, labor and infrastructure factors are considered complex factors in this study. However, as the analysis shows, many issues with the development of logistics in the development of transport are not linked to the development of the regional economy, are fragmented, and are not associated with the spatial or territorial development of the country's regions. This 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 summary of various methodologies, we came to the conclusion that in different countries, logistics factors affect socio-economic development in

[1] L.N. Gumilyov Eurasian National University; 2 Satpaev St., Astana, 010010 Kazakhstan; email: zh.raimbekov@gmail.com; orcid.org/0000-0002-4292-6966
[2] L.N. Gumilyov Eurasian National University; 2 Satpaev St., Astana, 010010 Kazakhstan; email: kunduz.sharipbekova@gmail.com; orcid.org/0000-0002-4292-6966
[3] L.N. Gumilyov Eurasian National University; 2 Satpaev St., Astana, 010010 Kazakhstan; email: bakyt_syzdykbaeva@mail.ru; orcid.org/0000-0001-9463-4933
[4] Al-Farabi Kazakh National University; 71 Al-Farabi Ave., 050040 Almaty, Kazakhstan; email: turginan@gmail.com; orcid.org/0000-0003-4208-6167
[5] Silesian University of Technology; Krasiński 8, 40-019, Katowice, Poland; email: aleksander.sladkowski@polsl.pl; orcid.org/0000-0002-1041-4309
* *Corresponding author*. E-mail: aleksander.sladkowski@polsl.pl

different ways. This situation means that individual approaches are required when using certain methods and indicators for research. The purpose of the present study is to assess the factors affecting the efficiency of the functioning of LS and economic growth. The main contribution of the study lies in the establishment of a group of factors affecting the country's economy as a whole, and in their comparison with regional logistics development indices. This analysis allows you to determine the impact of each component of logistics on the development of the regional economy and the economic growth of the country.

2. LITERATURE REVIEW

The harmonious development of the economy and logistics can lead to sustainable economic growth only through more efficient use of logistics resources [1]. Logistic factors influence the growth of national economies in different ways [2, 3].

The relationship between regional logistics and the regional economy was determined by considering 20 key factors [4]. It has been established that the import of transport and logistics services will improve transport and logistics services. The obsolescence and depreciation of the material and technical base of logistics, as well as a lack of personnel, hinder the effective development of logistics [5]. Through the use of advanced technologies such as computer networks, barcodes, navigation systems, and the digital economy, traditional logistics has turned into a high-performance, high-tech information industry with valuable content [6]. Therefore, several information support factors were adopted: the volume of communication services, mobile subscribers, and the percentage of internet users' people. In [7], a close relationship was established between economic development and different components of logistics, such as transportation, warehousing, processing, delivery, and information technology. The degree to which the logistics infrastructure influences the competitiveness and efficiency of the economy was defined and studied in [8, 9]. It was determined that the main driving forces for the development of transport are industry, trade, and agriculture.

The results of a quantitative analysis of a group of countries showed that a well-developed, managed, and maintained logistics infrastructure can significantly increase economic growth [10]. At the same time, in countries with small economies, an increase in demand for transport and logistics services and their infrastructure affects economic growth to a lesser extent than in countries with large economies [11]. The integrated activities of countries (customs, infrastructure, and information) in the field of trade have a positive effect on logistics and, accordingly, on economic growth, which can be seen in studies of countries participating in the "One Belt, One Road" initiative [12].

C. Bensassi and co-authors [13] studied the relationship between geographical and transport factors and the economy, finding 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 logistics potential can be presented as an aggregated indicator that takes into account individual territorial correlation coefficients [14]: 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 noted a close relationship between regional logistics and economic growth. However, the current research focuses on an 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 Gross domestic product (GDP); for example, one parameter is used to determine the development of logistics or economic development, the level of which is determined by the development of logistics and economic development. Measuring the indicators and potential of the transport and logistics system can be useful in making decisions in the field of investing in regional infrastructure in terms of pursuing an effective policy of socio-economic development.

3. RESEARCH METHODS

The following methods were proposed for assessing the impact of transport and logistics systems on the economy of Kazakhstan, which consists of the following stages. *In the first stage*, we singled 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. *In the second stage*, their effectiveness was determined by a standard discrete analysis of the seventh group of factors in Kazakhstan for the period from 2009 to 2020. The actual changes in these categories were determined using a general annual comparison. The influence of each factor on GDP was determined on the basis of regression analysis.

At the third stage, according to the data for 2014-2020, all logistics indicators brought to a comparable form based on normalization using a linear scale. The scale interval were between 0 and 1, where 1 is the maximum value and 0 is the minimum value Data evaluation based on linear scaling was used to normalize the indicators according to a previously used method [15], and the overall index I_{log} was calculated using the Formulas (1-3) below:

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

$$I_{ij} = \sqrt{i_{11} * i_{22} \ldots i_{nk}}, \quad (2)$$

$$I_{log} = \frac{i_{econ} + i_{inv} + i_{transport} + i_{mat\_tech} + i_{labor} + i_{inform} + i_{infr}}{7}, \quad (3)$$

where, I_i - index of the studied indicator for each factor in the region; $I_{current}$ – the initial value of the indicator for the analyzed region, $I_{min/max}$ - the minimum or maximum index value between groups for the analyzed region; I_{ij} – the index of the considered factor for the analyzed region; i_{nk} – the i-th indicator for the k-th considered factor for the analyzed region ($i = \overline{1,n}$; $j = \overline{1,k}$;), n – the number of indicators in a group of factors; k – the number of factors, i_{econ}, i_{inv}, $i_{transport}$, i_{mat_tech}, i_{labor}, i_{inform}, and i_{infr} – individual indices of the regions characterizing economic, investment, material and technical, labor, information and infrastructure factors, respectively, I_{log} – aggregate index characterizing the logistics index of Kazakhstan by region.

Indices according to formulas (1-3) were calculated for each of the 16 regions of Kazakhstan using the indicators presented in Table 1 (variables at the regional level).

The effectiveness of the development of the logistics system and economic growth was determined through 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_{log}); close to effective development (0.3< I_{log}<0.32); development with signs of inefficiency (0.27< I_{log}<0.3); inefficient development (I_{log} <0.27). *In the fourth stage*, a regression analysis was carried out to assess the influence of individual factors on economic growth. Twenty variables were proposed and considered as independent variables to assess the influence of factors on economic growth. *In the fifth stage*, a factor analysis was carried out based on the economic and mathematical model of the study to determine the sufficiency of variables and their division into specific groups.

All analyzes were performed in SPSS Statistics software. The second column of Table 1 presents indicators at the country level, which used to assess the impact of these factors on economic growth and to forecast GDP (for models 4 and 5). Indicators by regions were used to determine the indices of logistics development by region according to formulas (1-3).

4. RESEARCH RESULTS AND DISCUSSION

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

In the second stage of the methodology, seven groups of factors were evaluated. These are discussed in detail in the following paragraphs.

Economic factors. Between 2009 and 2020, the data for all four variables are positive (i.e., the figures grew every year). In particular, industry grew by three times, agriculture grew by four times, exports grew by 1.1 times, and imports grew by 1.4 times.

Table 1

Factors affecting macro- and regional logistics systems

Macro-environmental factors		
1	2	3
Category	**At the state level** (for calculations of 4-5 formulas)	**At the regional level** (I_{log} or for calculations of 1-3 formulas)
Economic factors	Volume of industrial production, including service (Indus), billion KZT (tenge)	The volume of industrial production in the region (Indus), mln. tenge
	Gross output of agricultural products, including service (Agri), billion tenge	Gross output of agricultural products (services) in the region (Agri), mln. tenge
	Trade turnover in tenge (Export), Export, mln. dollars	Wholesale volume (Export), mln. tenge
	Trade turnover in foreign currency (Import), Import, mln. dollars	Retail trade volume (Import), million tenge
Investment factors	Investments in fixed capital (Inv), billion tenge	Investments in fixed assets, transport, and warehousing by region (Inv), mln. 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 (InvTr), mln. tenge
	Fixed assets by transport enterprises (FA), billion tenge	Investments in fixed capital (FC), mln. tenge
Transport factors	Transported (transported) cargo, luggage, cargo luggage (Cargo), mln. tons	The volume of postal and courier services (Cargo), mln. tenge
	Freight turnover (Turn), billion t-km	Volume of freight traffic, (Turn), thousand tons
	Gross output of transport services (Output), billion tenge	Freight turnover (Output), mln. tkm
Material-technical support	Import of vehicles (ImpTr), thousand units	Investments in machinery, equipment, vehicles, tools and their overhaul (ImpTr), million tenge
	Commissioning of the main production capacities of transport through the construction of new enterprises and the expansion and reconstruction of existing enterprises (NewTr), mln. tenge	Commissioning and acquisition of new fixed assets (NewTr), mln. tenge
	Availability of trucks owned by citizens (Truck), thousand units	Availability of trucks (Truck), units
Human resources and personnel	Employed population in the transport industry (Labor), thousand people	Number of enterprises (Labor), units
	Average monthly salary of employees of transport enterprises (Sal), thousand tenge	Average monthly salary in transport and warehousing (Sal), tenge
	Number of transport enterprises (Firm), units	Employed in the economy, total, (Firm), units
Information technology factors	Volume of communication services (Com), billion tenge	The volume of communication services by region (Com), mln. tenge.

	Mobile cellular subscribers (per 100 people), (Mob)	Share of households with access to the Internet, (Int) %
	Individuals using the Internet (% of the population), (Int)	Number of fixed Internet subscribers, thousand units (Mob)
Transport infrastructure factors	Railway network density, km/thousand km^2 (DReal)	Operating length of the railway network in the region (DReal), thousand km.
	Road density, km/thousand km^2 (Davto)	Length of motor roads in the context of regions (Davto), thousand km
	Inland waterways (operated), km (Diwatw)	Share of waterways in regions (Diwatw) %

The discrete logistics statistics of the real sector of the economy were analyzed, where $R^2 = 0.95$ (coefficient of determination); that is, these variables affect about 95% of the gross domestic product (GDP) ($P_{value} < 0.0001$) used in testing the null hypothesis. Standardized coefficients regressions (β_j) allow them to be used when filtering factors from the model with the smallest standard deviation (S_{xi}). Table 2 shows that $\beta_{Indus} = 0.427$, $\beta_{Agri} = 0.564$, $\beta_{Exports} = -0.288$, and $\beta_{imports} = 0.175$. All but exports are positive, and deviations are negligible. Production in industry and agriculture increased by one $S_{Industry}$ and $S_{Agriculture}$, respectively. Meanwhile, GDP increased to $0{,}427S_y$ and $0{,}564S_y$. Thus, the factors of industry and agriculture had a significant impact on GDP than the factors of trade turnover (exports and imports).

With an increase in the calculated predicted gross domestic product (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, and import by 0.311 units (Table 2). However, each year from 2009-2019, the standard deviation of economic factors' dispersion was between -1 and 1.5. The largest negative deviation occurred in 2013, when the standard deviation was less than 0.891 units. The maximum positive deviation in 2015 was greater than the standard deviation by 0.971 units (Fig. 1). Similar analyses were carried out for the rest of the factors**.**

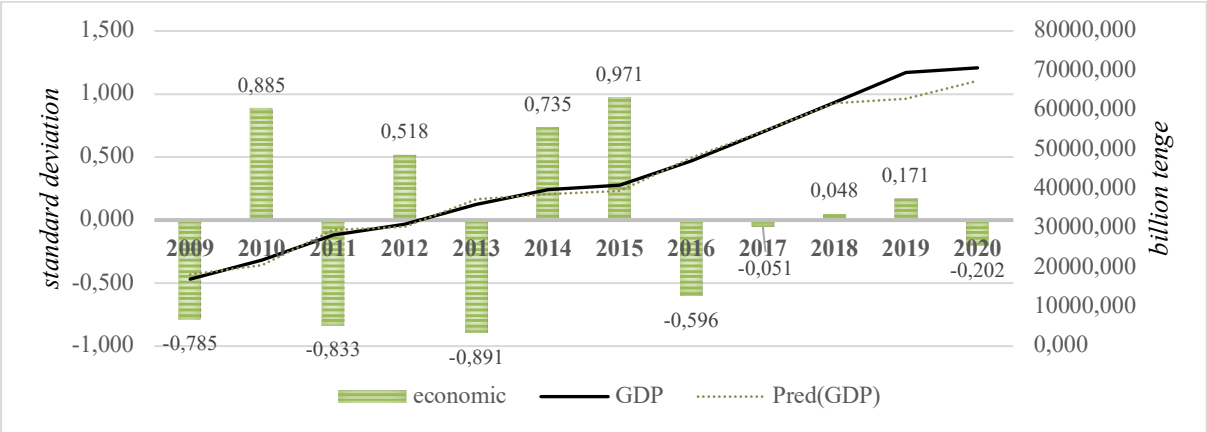

Fig. 1. Discrete statistical analysis of the real sector of the economy from 2009-2020

Investment factors. Between 2009 and 2020, the data for all two variables were positive (i.e., the figures grew every year). We analyzed the discrete statistics of LS on investment income, where $R^2 = 0.978$ (i.e., these variables affected approximately 97% of GDP, $P_{value} < 0.0001$). The values of standardized coefficients of $\beta_{Inv} = 0.163$, $\beta_{InvTr} = 0.056$, and $\beta_{FA} = 0.809$ had a positive value, and the deviations were insignificant. With an increase in the estimated Pred(GDP) by one unit, all variables increased in parallel (Table 2). The *InvTr* correlation coefficient is above 90%. For this reason, the indicator InvTr was excluded from further calculations.

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deviation was less than 0.891 units, and the maximum positive deviation in 2015 was greater than the standard deviation by 0.971 units.

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 were positive (i.e., they grew every year). The values of β-coefficients, respectively, are equal for the volume of cargo transportation - 0.491, cargo turnover - 0.609 and Gross output of transport services - 0.817. This means that GDP is significantly affected by freight turnover and Gross output of transport services. As Pred(GDP) grew, freight turnover increased by 128.0 units, transport output increased by 7.444 units, and traffic volume increased by 1,048 units (see table 2). The βcargo coefficient is above 90%, therefore, it was excluded from the region of calculations.

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

Human Resources and Personnel variables. Between 2009 and 2020, data for all three variables were positive (i.e., the numbers grew every year). 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 $P_{val} < 0.0001$, the values of the standardized coefficients $\beta_{Labor} = -0.094$, $\beta_{Sal} = 0.804$, $\beta_{Firm} = 0.278$. The employed population is negative but not less than -1. The other two variables are positive, and the deviations are insignificant (Table 2). As the estimated Pred(GDP) increased by one unit, the employed population variable decreased by -29.28, the remaining wage increased by 321.9 units, and the number of firms increased by 13.08 units.

Variables related to the use of information technology. The number of mobile subscribers with the least change varied from 106,359 units per hundred to 138,582 units, representing an increase of 1.3 times. The volume of additional communication services varied from 438.4 billion tenge to 854.6 billion tenge, almost doubling. 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 are as follows, where $R^2 = 0.864$ (i.e., these variables affect about 86% of GDP, $P<0.0001$ value, standardized coefficients: $\beta_{com} = 1.313$, $\beta_{mob} = -0.149$, $\beta_{Internet} = - 0.29$). Except for communication, all variables had negative values, but the deviations were insignificant since they did not exceed -1. If the calculated Pred(GDP) increased by one unit, then the communication variable increased by 91.05 units, mobile communication decreased by -164.0 units, and the Internet increased by 247.48 units (Table 2). The $\beta_{Internet}$ coefficient is above 90%; Therefore, we excluded this indicator from the calculations.

Transport infrastructure variables. The density of the rail and road networks was directly proportional to economic growth, while the density of inland waterways was inversely related (Table 2). As a result, it can be said that the development of the logistics sector in the country is one of the most important factors determining economic growth.

This study showed a strong relationship between logistics variables and economic growth and indicated that this relationship has a direct impact on economic growth. First, a dynamic structural model was used for the six obtained factors: transport, investment income, logistics, the real sector of the economy, human resources, and information support. Using a dynamic structural model allowed us to 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 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 the creation of logistics today centers on the basis of public-private partnerships, investments are required 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.

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 based on 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 Formulas 1, 2 and 3 based on the economic indicators of the region and the indicators of the logistics system [15].

All regions of Kazakhstan were analyzed based on the criteria in Table 3, which were divided into four groups. The regions with the highest scores for all criteria are Almaty (0.38), Astana (0.37), Mangistau (0.34), Akmola (0.32), and Pavlodar (0.32). Weak development and the lowest indicators of logistics were observed in Atyrau (0.26), East Kazakhstan (0.26) and Zhambyl (0.24), which were 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) were 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 had a higher potential than agro-industrial zones. For example, the highest levels of logistics potential were in the Almaty region, Mangystau region, Almaty, Akmola region, and Pavlodar region. The lowest levels of logistics potential were in Atyrau, East Kazakhstan, and Zhambyl. In other areas, the logistical potential was moderate.

A comparative analysis of individual indicators allows Us to conclude that the growth rates of investment and logistics were high and evenly distributed across regions; however, in economically underdeveloped regions, the logistics potential of these indicators was low.

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

By analyzing the studies of other authors, we have formed 22 macroeconomic indicators of Kazakhstan. Of these, GDP is an indicator, and the remaining 21 are independent variables, and we conducted a factor analysis. As a result of the study, we focused on the following issues: the correlation matrix of variables, the Kaiser-Meyer-Olkin results, the internal significance of factors, the factorial model, and factors after the 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. FC was excluded from the next factor analysis due to the high correlation value (0.71). According to the results of factor analysis, Cronbach's alpha was 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 [16]. The Kaiser-Meier-Olkin (KMO) index indicates the adequacy of the sample. The KMO in our model was 0.733, which reflects a satisfactory sample value [17].

Table 4 shows the eigenvalues obtained as a result of the factor analysis for 20 variables from 2009–2020, as a result of which we identified nine factor groups. The eigenvalue of the factors in the first factorial group was 8.856, and its percentage variability was 73.8% (i.e., the influence of variables within this factor group was high). Then, the value of the second group of factors fell sharply to 2.127, and its variability was 17.73%. That is, it was confirmed that the variables in these two-factor groups were 91.53% of 100% and, in general, had all the calculated effects, and the influence of the remaining factor groups was very low or did not change. The maximum value was chosen in absolute

terms to determine the components of each factor. Thus, we have chosen two important groups of factors, and they are as follows (Tab. 5).

As shown in Table 5, the maximum value was 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 this variable was chosen.

Table 2

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

Dependent variable GDP (Gross domestic product)	*GDP = β0 + β1 X1 + β2 X2 + β3 X3+ β4 X4+ β5 X5+ β6 X6+ β7 X7*				
Independent variables:	coefficient	std error	t-stat	β-coefficient	Prob (P-value)
1) Economic variables: R^2 (Determination coefficient) = 0.9904; F (Fisher's criterion)=181.2					
Indus	1.8154***	0.322	5.637	0.427	0.0007
Agri	4.2887**	1.208	3.550	0.564	0.0380
Export	-0.2102**	-0.077	2.729	-0.288	0.0299
Import	0.3114*	0.133	2.324	0.175	0.0566
b_0	81.6577	52.244	1.563		0.9825
2) Variable investments: R^2 = 0.9859; F = 186.5					
Inv	1.100***	0.163	6.748	0.163	0.0030
InvTr	5.115***	0.056	91.339	0.056	0,0054
FA	3.8712***	0.809	4.258	0.809	0.0096
b_0	2476.941	291.925	8.488		0.8934
3) Transportation variables: R^2 = 0.9510; F = 51.8					
cargo	1.048***	0,049	3.482	0,491	0.0030
Turn	128.035**	56.778	2.255	0.609	0.0281
OutputTr	7.444***	1.620	4.594	0.817	0.0017
b_0	-6141,634	128.423	47.823		0.000
4) Material-technical support variables: R^2 = 0.8857; F = 30.6					
ImpTr	-37.836*	-17.461	2.167	-0.221	0.0553
NewTr	- 1.219*	-0.525	2.321	-0.029	0.0492
Truck	683.583***	99.457	6.8731	0.879	0.0001
b_0	-136781.362***	524,241	260.913		
5) Human resources and personnel variables: R^2 = 0.8858; F = 185.2					
Labor	-29.2811**	-10.017	2.923	-0.094	0.0305
Sal	321.9038***	64.349	5.0024	0.804	0.0010
Firm	13.0280*	4.634	2.8112	0.278	0.0672
b_0	73319.411	1114.54	65.784		
6) Variables on the use of information technology: R^2 = 0.9723; F = 93.8					
Com	91.0547***	23.546	3.867	1.313	0.0070
Mob	-164.0071**	-57.973	2.829	-0.149	0.0324
Internet	247.4811***	8.916	27.754	0.290	0.0025
b_0	-40689.2661	285.825	142.357		
7) Transport infrastructure variables: R^2 = 0.9301; F = 35.9					
DReal	86975.188***	9751.764	8.9189	0.899	0.0001
Davto	432.204**	192.224	2.2551	0.015	0.0488
Diwatw	-48650.983*	32051.49	-1.5179	-0.157	0.1675
b_0	-383786.259***	116643.84	-3.290		0.0110

Note: Significance level *p < 0.05, **p < 0.01, ***p < 0.001.

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

$$Model\ 1_{(GDP)} = \beta_0 + \beta_{1inv} + \beta_{2truck} + \beta_{3sal} + \beta_{4turn} + \beta_{5indus} + \beta_{6com} + \beta_{7Dreal} \quad (4)$$

$$Model\ 2_{(GDP)} = \beta_0 + \beta_{1invTr} + \beta_{2impTr} + \beta_{3firm} + \beta_{4agri} + \beta_{5cargo} + \beta_{6mob} + \beta_{7Davto} \quad (5)$$

The results of the ANOVA test showed a very high correlation between factors and GDP models (Tables 6 and 7). Model 1 (Table 6) shows that, with an increase in GDP by one unit, increases were observed in investments in fixed assets increased by 2.558 units (β_{Inv} = 0.418), competitive industrial output by 0.313 units (β_{indus} = 0.305), communication services by 73.3 units (β_{com} = 0.586), freight turnover by 8.214 units (β_{turn} = 0.139), and the average monthly salary of employees of transport enterprises by 45.429 units (β_{sal} = 0.110). However, the number of trucks owned by citizens decreased by 79,237 units (β_{truck} = -0.104). In addition, R^2 = 0.997 (i.e., these variables affect about 99% of GDP, P-value = 0.001).

Table 3

Regional results in terms of logistics development indicators

Rank	Regions	I_{log}	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	Astana	0.31	
4	Turkestan	0.31	
5	West Kazakhstan	0.30	
6	Kustanai	0.29	Average level of development or satisfactory development
6	Kyzylorda	0.29	
6	East Kazakhstan	0.29	
7	Karaganda	0.27	
8	Atyrau	0.26	LS is ineffective or very poorly developed
8	North Kazakhstan	0.26	
9	Zhambyl	0.24	

Table 4

Specific values of factor groups for 20 variables from 2009–2020

Factor group	1	2	3	4	5	6	7	8	9
Eigenvalue	**8.856**	**2.127**	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

Model 2 shows (Table 7) that the R-squared values (97%) are very high. In all three samples, the P-value was 0.05 (or 5% lower), and the F-Stat values were significantly higher, which means that they are statistically significant. As can be seen from Table 7, with a one-unit increase in GDP, the import of vehicles increased by 12.203 units ($\beta_{ImportTr}$ = 0.056); the total output of agricultural products increased by 7.04 units (β_{agri} = 0.541); the number of mobile subscribers increased by 130.93 units (β_{mob} = 0.159); the number of transport enterprises increased by 1.94 units (β_{firm} = 0.042); and the volume of transported goods, luggage, hand luggage increased by 14.9 units (β_{cargo} = 0.528). However, investments in fixed assets from all modes of transport by modes of transport decreased by 4.844 units (β_{InvTr} = -0.096).

Fig. 2 is a diagram summarizing Models 1 and 2 resulting from this factor analysis. It can be seen that the deviation of the first group of factors from total GDP1 to real GDP is very small. Only the latest years (2018-2020) show a slight deviation. At the same time, although the diagram of factor group 2 has some deviations, it changed little from the 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%.

Table 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	**0.089**
Investments in fixed assets	**0.319**	-0.098
Import of vehicles	0.033	**-0.210**
Availability of trucks owned by citizens	**0.053**	0.050
Cargo transported	0.038	**0.054**
Turnover	**0.090**	-0.076
Average monthly salary of employees of transport enterprises	**0.086**	-0.065
Number of transport companies	0.003	**0.064**
Volume of industrial production	**0.082**	-0.046
Gross output of agricultural products	0.053	**0.053**
Scope of communication services	**0.307**	-0.067
Mobile subscribers	0.044	**0.067**
Railway network density	**0,079**	-0,025
Road density	**0,089**	-0,040
Inland waterways	0,024	**-0,664**

Table 6

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

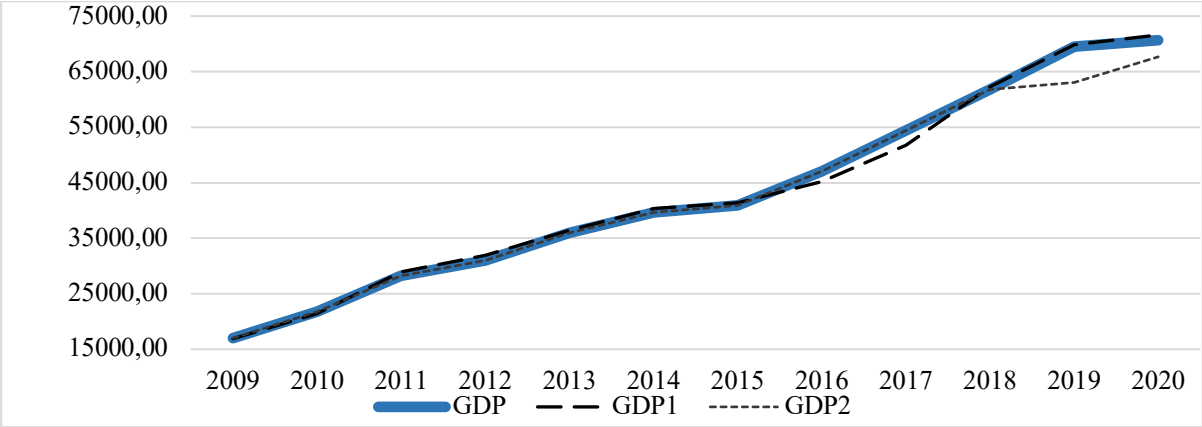
Independent variables	*Coefficient*	*Std error*	β-coefficient	*t-stat*	*Significance*
β0	-102150,762	17727.404		-5.762	0.005
β1inv	2.558	0.385	0.418	6.645	0.003
β2Truck	-79.237	28.750	-0.104	-2.756	0.054
β3Sal	45.429	18.889	0.110	2.405	0.502
β4Turn	8.214	4.144	0.139	1.982	0.038
β5Indus	0.313	0.105	0.032	2.953	0.050
β6Com	73.319	21.078	0.586	3.479	0.025
β7DReal	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	

Table 7

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

Independent variables	*coefficient*	*std error*	β-coefficient	*t-stat*	*significance*
β0	63025.233	87026.741		0.724	0.509
β1InvTr	-4.844	1.789	-0.039	-2.707	0.530
β2ImportTr	12.203	2.542	0.056	4.799	0.048
β3Cargo	14.190	6.295	0,528	2.254	0.032
β4Firm	1.948	1.041	0.042	1.871	0.408
β5Agri	7.046	2.250	0.541	3.132	0.035
β6Mob	130.937	22.478	0.159	5.825	0.062
*β7*Davto	2230.175	1136.105	-0.079	1.963	0.209
F stat	41.998			R^2	0.971
Durbin-Watson	1.824			*P-value*	0.010

The sum of the two groups of factors is 91.5%, and it was found that the variables belonging to this group of factors have a high impact on GDP. Therefore, by 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 (β = 0.851). This means that the growth of industry, inv., turnover, communication, and Dreal 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 (β = 0.149) than the group of factors F1. The priority factor is increases in investment in the transport industry, 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 from using indicators according to Formula (4) of the first factor group 1
***GDP2 - GDP formed from using the indicators of the applied Formula (5) of the second factor group 2
Fig. 2. Diagram comparing GDP1 and GDP2 with real GDP, formed from factor analysis using Formulas (4) and (5)

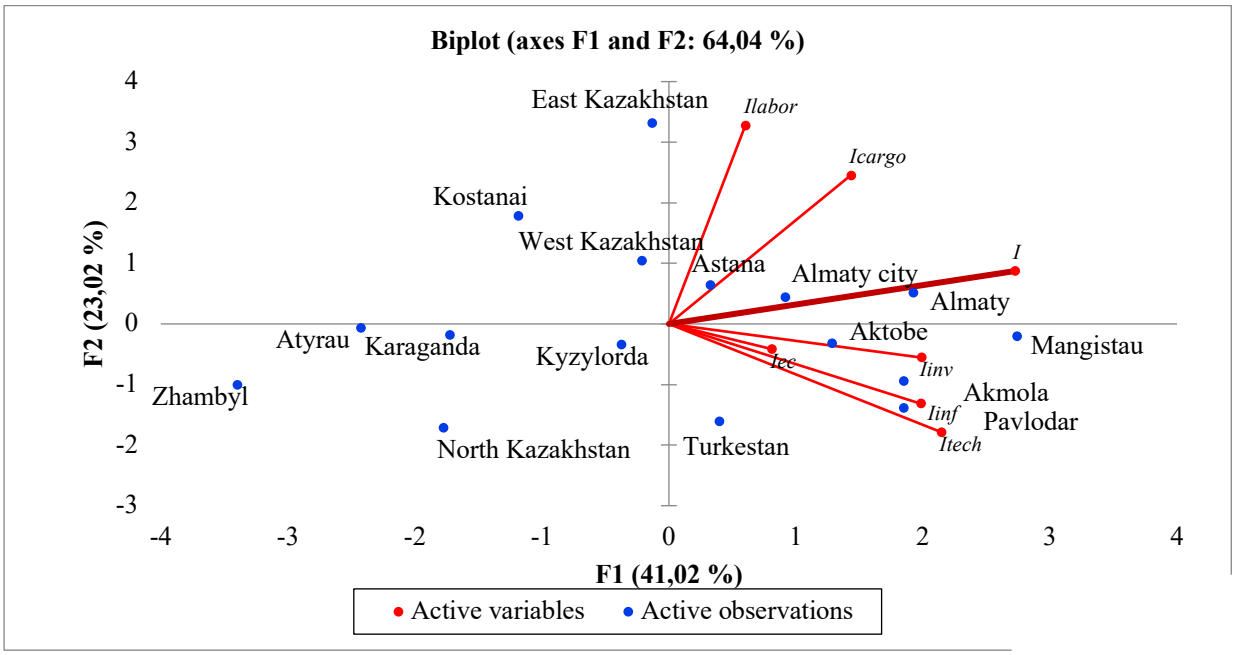
As shown in Fig. 3, the indicators between the variables of the first and second groups of factors were evaluated by regional LS indices. The figure shows the level of effective operation of the following drugs in the regions, where the typology of the regions of Kazakhstan are divided into four groups according to the level of economic development:

Group 1 – These regions have a high level of development of transport infrastructure and human resources, more efficient development of drugs, which affects economic growth. 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). It is necessary to introduce a comprehensive program to develop logistics in the regions included in this group and plan to increase the following indicators: Agri, Mob, InvTr, and Firm. These regions have a good chance to solve these problems at their own expense.

Group 2 - The level of development or medium development zones is close to the effective LS, which affects economic growth. It is closest to the aggregated indicator and has a positive value both for the F1 factors and for the F2 factors for the Mangistau, Akmola and Pavlodar regions, except for the Aktobe region, where the F2 factors have a negative value. For the second group, the improvement of the LS of the region should be taken into account in programs of national importance with the participation of the state in financing and design. In such cases, it is necessary to create measures to increase the F2 factors in West Kazakhstan and East Kazakhstan regions. The increase in investment in transport infrastructure, the import of vehicles, and the increase in freight traffic and transport enterprises are important. Conversely, the factors included in the F1 group are steadily developing and do not require additional measures.

Group 3 – These regions have an average level of development of LS or satisfactory development. 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 while taking into account the factors affecting these regions.

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



* I_{ec} - Real sector of the economy, I_{labor} - Labor resources, I_{inv} - Income from investments, I_{cargo} - Cargo transported, I_{teh} - Logistics, I_{inform} - 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

As can be seen from Table 8, the value of F1 increased by an average of 5.0% per year and had a positive value. The total value of F2 also increased each year and has a positive value with an average growth rate of 2.6%. For the period from 2021-2030, a forecast was made using statistical methods, using time series, and using real GDP data from 1991-2020. The forecast variables for the group of factors F1 (Industry, Inv., Turnover, Truck, Salary, and Communication) were used.

Based on the group of forecast factors in Table 8, real GDP is projected at 2% per annum compared to the previous year (2022-2030). The influence of F1 factors on the economy averages 85%, and the factors of the F2 group have a low influence of -15%. The analysis of factors influencing macro-level 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 the level of development of logistics in each region of the country. The dependence and degree of the influence of each factor on GDP were determined.

Based on the factor analysis using 20 variables, two groups of factors were identified as having a high degree (91.5%) of influence on GDP. Similar studies were carried out in [6, 8, 10, 13], and the resulting groups of factors are consistent with this research. The conclusions obtained in this study again confirm the consideration of these factors and a differentiated approach to the development of regions. It was found that increases in the indicators of Industry, Inv., FA, Turnover, Truck, Communication, Davto, and DReal led 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 was less than 2.0%. The influence of the group of factors F1 on the economy was 85%, and the influence of the group of factors F2 was 15%. In other words, F1 influences economic growth 5.5 times more strongly than F2. Therefore, when compiling a program for the development of the regional economy, it is necessary to pay more attention to factors F1 than factors F2. These factors must be taken into account when drawing up a program for the development of a territory.

Table 8

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	742 227	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

5. CONCLUSIONS

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

The acceleration of economic growth in the regions of Kazakhstan requires the government, regional authorities, and businesses to take a differentiated approach to financing and investing in logistics projects. At the same time, one should consider the improvements in indicators included in the group of factors F1 (production volume, investments in fixed capital, freight turnover, the quality of transport and logistics services and communication services, and the construction and modernization of railway and automobile networks).

Based on the factor-index analysis, a forecast was made for the development of logistical factors that affect the efficiency of the country's economy. The forecast is based on the studied factors up to 2030. The forecast showed that the annual growth rate of the F1 factor group as a whole was twice as high when compared to the F2 factor group. These factors F1 have a more positive effect on economic growth and increase the competitiveness of the logistics services market, which must be considered when drawing up programs for the development of the regional economy.

The analysis confirms the need to include the following in the republican program for the development of the country: increasing the volume of production and modernizing industry and communications, cargo turnover, investment in fixed assets, and increasing the density of roads and railways. Meanwhile, in regional programs for the development of the economy, it is necessary to develop the volume of agricultural production, volumes of transport and logistics, postal and courier services, and increases in vehicle imports.

In the current situation, the following measures are important for Kazakhstan to improve the operation of the transport infrastructure, which has a profound impact on the economy: updating and increasing the efficiency of the use of fixed assets, the construction and creation of inter-regional high-speed roads and high-speed railways connecting large areas in the most populated areas of the country and serving export-transit cargo flows, multimodal transport and logistics centers, and the digitalization of the industry.

Such measures will allow the transport and logistics industry 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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Received 12.06.2021; accepted in revised form 28.11.2022