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Methodical Approaches to the Assessment of Relationships Between the Parameters of the Transport Potential of Ukraine

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Abstract

The article's purpose is to justify methodological approaches to assessing relationships between the parameters of Ukraine's transport potential. Methodical approaches to the evaluation of the relationships between the parameters of the transport potential of Ukraine based on the interpretation of the "transport potential" category are proposed by distinguishing its main parameters - resource provision and functioning results, between which there is a relationship, namely: the level of resource provision forms the functioning results. We suggest that resource support be characterized by statistical indicators that reflect material, human, and investment resources, and the development of functioning by the value measurement of the volume of products sold by the type of economic activity "Transport, warehousing, postal and courier activities". A correlation dependence between the importance of actually produced products in the transport system and the corresponding indicators of resource provision has been proven. It has been proven that capital investments have the greatest influence on the increase in the value of the results of the functioning of the transport sector. The functional form of the constructed correlation levels creates an economic-mathematical assessment of the actual state of the impact of material, human, and investment resources on the results of the functioning of the transport sector. Also, it makes it possible to structure resources to achieve the desired result and form forecasts of the development of the transport sector. Proposed methodical approaches with the possibility of further growth in the direction of developing mechanisms for stimulating the gradual modernization of the transport system of Ukraine, which will be especially relevant in the post-war reconstruction of the country's infrastructure and economy. It was emphasized that Ukraine needs to improve the state policy on transport. In particular, it is necessary to create conditions for effective control over the level of performance of executive authorities' powers to ensure transport's functioning. To fulfill the tasks of the National Transport Strategy of Ukraine for the period until 2030, in particular, to improve the systems for collecting and analyzing statistical data on the development of transport in Ukraine.

Keywords: transport potential, transport system, systematic methods, correlation equations, economic and mathematical modeling.

1.   Introduction.

Today, the transport system plays a vital role in ensuring the country's socio-economic development. It performs the optimization of various flow processes related to transportation. The effectiveness of the functioning of the transport system depends on the use of organizational and innovative reserves, which acquires special importance in countering Russian aggression. The destruction of the infrastructure, which is observed in Ukraine as a result of the Russian invasion, additionally actualizes the need to study issues related to the development of the transport system and the restoration of transport potential to ensure production processes and systematize flow processes in the socio-economic sphere.

In addition, A. Yu. Platonov notes that Ukraine, thanks to its favorable geographical location, has significant transit potential, which is confirmed by the passage of seven international transport corridors through the territory of our state. However, the study of the dynamics of transit and the total volume of international freight transportation revealed a significant problem - the discrepancy between the high level of the domestic potential for the development of international freight transportation and the decreasing trends in the volume of international transportation of goods through the territory of the country. Factors of non-tariff regulation of customs procedures and foreign trade operations (resulting in delays in passing customs procedures), as well as restructuring processes of state bodies managing the

transport industry (frequent changes in legislation, changes in tariffs), which create the potential for the formation of a corruption component, are significant obstacles to the realization of Ukraine's transport potential. Manifestations of financial, economic, infrastructural, and institutional factors also obstruct Ukraine's transit potential development. Together, they lead to a decrease in the efficiency of international freight transportation due to the increase in the cost of international freight transportation [1].

S. Lutsenko emphasizes that "The main role in attracting transit cargo belongs to the state, because it is with the help of state decisions that it is possible to reduce administrative barriers (customs legislation), improve information provision, creating convenient conditions for both shippers and receivers, and logistics operators based on the best global models, such as, for example, the PORTNET information and logistics system, which simplifies and synchronizes logistics processes for all participants in transit transportation and makes Singapore Seaport the most efficient port in the world." [2]

The transport system of Ukraine at the state level is considered as a sector of the economy that "has an extensive railway network, a developed network of highways, seaports and river terminals, airports and a wide network of air connections, cargo customs terminals, which creates the necessary prerequisites for meeting the needs of transport users in provision of transport services and business development" [3].

The transport system is the most important component of the integration of the world economy. Therefore, the world community, using the resource potential of states and their spatial location, strives to form a unified transport system. And, of course, given the geographical location of Ukraine and its capabilities, it is necessary to improve the infrastructure, implement already existing transport strategies and implement new ones, and increase our competitiveness. In addition, it is necessary to effectively use the existing transport networks, increase the technological level, contribute to investment attractiveness, and regulate the legal framework in favor of easing customs procedures. [4]

It should be noted that the national transport system is a component of the world transport system. It consists of such elements as railway, road, pipeline, water, and air transport. Subjects of the transport system include international transport organizations, international integration transport systems, state transport authorities, transport industries, transport enterprises, and individual individuals. The levels of the transport system are global, international, regional, interstate, interregional, international competition, cooperation of enterprises, and nano level. All elements, subjects, and levels are subject to the process of forming relations of the transport system, i.e., the execution of the transport contract. There are also methods of regulation of the transport system, namely regulation at the level of the state and administration and the level of enterprises [5].

Previous studies indicate that significant attention has been paid to the study of the assessment of transport and transport-logistics potential [6]. However, the war in Ukraine greatly changed the previously established socio-economic development conditions. Therefore, there is a need for further exploration of issues related to the peculiarities of assessing the transport potential and the relationships between individual parameters of the transport potential of Ukraine.

At the level of the government of Ukraine, it is recognized that "the transport industry as a whole satisfies only the basic needs of the population and the economy in transportation in terms of volume, but not in terms of quality. The current state of the transport industry does not fully meet the requirements of the effective implementation of the European integration course of Ukraine and the integration of the national transport network into the Trans-European transport network" [3].

Today's Ukraine is distinguished from other countries by the fact that a significant number of its cities are located on traditional transport and communication routes of the Eurasian continent. The state has a fairly high coefficient of transitivity (transport attractiveness), but this indicator, so to speak, is potential and can be realized only in serious

competition with other states. Targeted consideration of potential opportunities will help Ukraine achieve a new level of development on the way to realizing its main priorities, including in the field of providing transport services [7].

2. Discussion.

Further studies of theoretical and methodological approaches to evaluating the parameters of the transport potential of Ukraine will help to fulfill the tasks outlined by the global directions of the development of the transport system (Fig. 1).
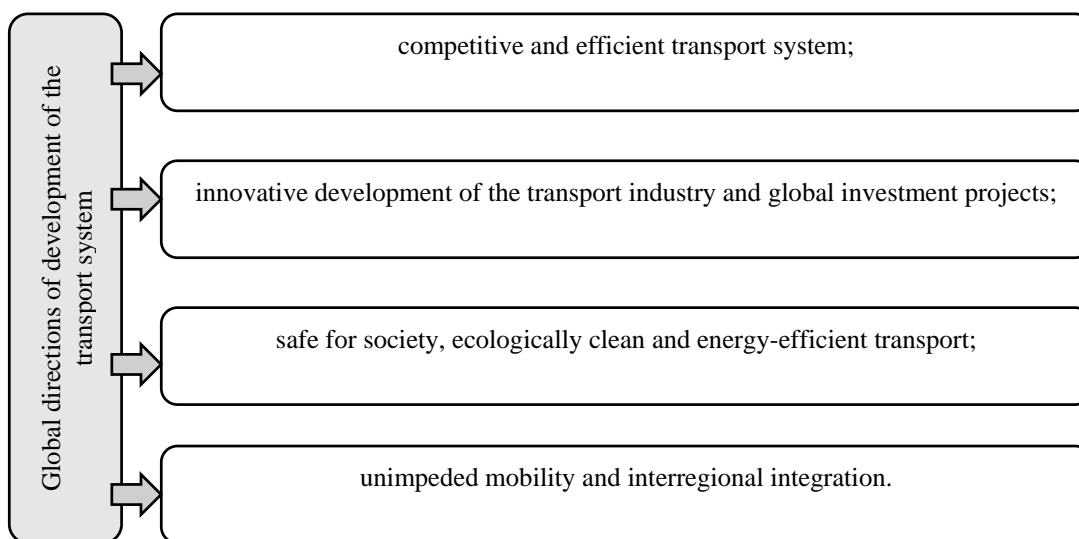
Fig. 1. Global directions of transport system development

Source: [3].

The national transport system of Ukraine faces the primary task of implementing modern principles of state policy in the field of transport and creating prerequisites for effective control over the level of performance of its powers to ensure the functioning of transportation by executive authorities. The National Transport Strategy of Ukraine for the period until 2030 also provides for the implementation of the task of "improving the system of collection, analysis and use of statistical data" [3], which additionally proves the relevance of developing methodical approaches to assessing the relationships between the parameters of the transport potential.

Many published results of research on transport potential are based on the opinions of individual experts and reproduce the results of generalizations of their previous experience, which creates a particular subjectivity regarding the possibilities of their distribution in current conditions. To ensure the objectivity of the results of the evaluation of the transport potential of Ukraine, we suggest using the capabilities of contemporary application programs for processing data confirmed by state statistical authorities.

An essential element of such studies is the substantiation of methodological approaches to assessing the relationships between Ukraine's transport potential parameters. As a theoretical basis for methodical approaches to evaluate the relationships between the parameters of the transport potential of Ukraine, it is advisable to generalize the existing definitions of the categories related to the transport potential.

Under the category "transport potential" we propose to understand the set of resource possibilities (material, human resources, investment resources, etc.) used to achieve the results of the functioning of the transport system or to carry out transportation. The State Statistics Service of Ukraine records and publishes data on the results of production of the transport system in the form of the value indicator "volume of sold products (goods, services) of enterprises by type of economic activity "Transport, warehousing, postal and courier activities", which is measured in millions of hryvnias. And among the data on resource provision, it is possible to distinguish three groups of indicators: material (initial cost of fixed assets and cost of new fixed assets), human (average accounting number of full-time employees), and investment (capital investment) resources, which are also determined by the type of economic activity "Transport, warehousing, postal and courier activities" (Table 1).

Table 1. Characteristics of the transport potential of Ukraine for 2015-2021

	2015	2016	2017	2018	2019	2020	2021
Volume of sold products (goods, services), million UAH (P2); Y	5318957,7	6387873	7862695	9388092	9841061	10273152,5	11844232
The original (revalued) cost of fixed assets, UAH million (MR1) X_1	7641357	8177408	7733905	9610000	9574186	10577278	10960292
The cost of new fixed assets received, UAH million (MR2) X_2	216697	202120	237793	306147	437695	376384	453491
Average registered number of full-time employees, thousands of people (LR1) X_3	661,4	659,9	655,2	648,4	635,1	625,8	621,7
Capital investments, UAH million (IR1) X_4	273116,4	359216,1	448461,5	578726,4	623978,9	508217	675291,7

Source: data of the State Statistics Service of Ukraine [12]

The hypothesis of the study is that the volume of realized products (goods, services) (Y) stochastically depends on the amount of material (X1, X2), investment (X3) and human resources (X4). Stochastic models of interrelationships characterize the influence of several factors on the resulting value. Such models are described using the tools of correlation-regression analysis, which involve the construction of regression equations to characterize the correlation dependence. Correlation-regression analysis helps to understand the peculiarities of the studied relationships and to determine the factors for achieving the goals. One stochastic regression equation is most often used [13].

For a functional presentation of the dependence of the volume of products sold in the field of transport on the amount of material, investment and human resources, we will use the Microsoft Office package, namely Microsoft Excel, which has tools for simplifying time-consuming analytical calculations.

The level of approximation of the functional representation of the regularity of changes in the volume of realized products in the field of transport depending on resource provision will be characterized using the coefficient of multiple determination [13]:

$$R^2 = \frac{\Sigma(Y' - \bar{Y}')^2}{\Sigma(V_i - \bar{Y})^2} \tag{1}$$

where Y_i is the actual value of the i-th indicator;

$\bar{Y}$ - Average value;

Y_i' – Estimated values.

The less the estimated and actual values differ from each other, the greater the value of the coefficient of multiple determination approaches 1 [13].

The regression function will look like this:

$$Y = \beta_0 X_0 + \beta_1 X_1 + \beta_2 X_2 + u \tag{2}$$

u – deviation of the actual indicators from the estimated data ($u_i = Y_i - \widehat{Y}_i$).

Regression coefficients β are found by the method of least squares:

$$\hat{\beta} = (X' \cdot X)^{-1} \cdot X' \cdot Y \tag{3}$$

where

$$X = \begin{bmatrix} 1 & 7641357 & 216697 & 661,4 & 273116,4 \\ 1 & 8177408 & 202120 & 659,9 & 359216,1 \\ 1 & 7733905 & 237793 & 655,2 & 448461,5 \\ 1 & 9610000 & 306147 & 648,4 & 578726,4 \\ 1 & 9574186 & 437695 & 635,1 & 623978,9 \\ 1 & 10577278 & 376384 & 625,8 & 508217 \end{bmatrix}$$

$$X' = \begin{array}{ccccccc} 1 & 10960292 & 453491 & 621,7 & 675291,7 \end{array}$$

$$X' = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 7641357 & 8177408 & 7733905 & 9610000 & 9574186 & 10577278 & 10960292 \\ 216697 & 202120 & 237793 & 306147 & 437695 & 376384 & 453491 \\ 661,4 & 659,9 & 655,2 & 648,4 & 635,1 & 625,8 & 621,7 \\ 273116,4 & 359216,1 & 448461,5 & 578726,4 & 623978,9 & 508217 & 675291,7 \end{bmatrix}$$

$$X'X = X \begin{bmatrix} 7 & 64274426 & 2230327 & 4507,513333 & 3467008 \\ 64274426 & 6,01098E+14 & 2,12319E+13 & 41262629390 & 3,28054E+13 \\ 2230327 & 2,12319E+13 & 7,76977E+11 & 1426472675 & 1,18624E+12 \\ 4507,513333 & 41262629390 & 1426472675 & 2904132,689 & 2220933116 \\ 3467008 & 3,28054E+13 & 1,18624E+12 & 2220933116 & 1,84332E+12 \end{bmatrix}$$

$$(X'X)^{-1} = \begin{bmatrix} 7500,02716 & -7,45624E-05 & -0,000992819 & -10,2978955 & 0,000266938 \\ -7,45624E-05 & 1,13103E-12 & 5,79873E-12 & 9,9362E-08 & -3,3367E-12 \\ -0,000992819 & 5,79873E-12 & 2,47711E-10 & 1,39559E-06 & -7,67454E-11 \\ -10,29789551 & 9,9362E-08 & 1,39559E-06 & 0,014167228 & -3,67103E-07 \\ 0,000266938 & -3,3367E-12 & -7,67454E-11 & -3,671E-07 & 4,95497E-11 \end{bmatrix}$$

$$y = \begin{bmatrix} 5318957,7 \\ 6387872,7 \\ 7862695,2 \\ 9388092,1 \\ 9841060,7 \\ 10273152,5 \\ 11844232 \end{bmatrix} \qquad (X'y) = \begin{bmatrix} 60916062,9 \\ 5,76608E+14 \\ 2,07328E+13 \\ 39014906073 \\ 3,20665E+13 \end{bmatrix}$$

$$\hat{\beta} = (X' \cdot X)^{-1} \cdot X' \cdot Y = \begin{bmatrix} 83281229,21 \\ -0,05818365 \\ -11,5730213 \\ -118551,186 \\ 12,0766526 \end{bmatrix}$$

Thus, the regression equation of the dependence of the volume of products sold in the field of transport on the amount of material, investment and human resources will be:

$$Y = 83281229,21-0,05818365*X_1-11,5730212972953*X_2-118551,186*X_3+12,0766526*X_4$$

Thus, of all the factors of influence under consideration, it is capital investments that affect the increase in the value of the sold products (the ambassador) in the field of transport. Other things being equal, an increase in the amount of capital investments in the transport sector by UAH 1 million affects the increase in the volume of sold products (services) by UAH 12.08 million, respectively.

The adequacy of the built model of the stochastic dependence of the volume of realized products in the field of transport on the amount of material, investment and human resources will be checked by determining the deviation of the average actual values and the average calculated values of the resulting characteristic (calculations in Table 2):

$$\bar{y}=\frac{\sum Y_i}{n}= 8702294,7; \qquad \bar{Y}'=\frac{\sum Y_i'}{n}= 8702294,7$$

equality $\bar{Y}=\bar{Y}'$, proves the correctness of previous assumptions and calculations.

Table 2. Calculation of deviations of the average actual values and average estimated values of the volume of products (services) sold in the field of transport

	y_i	Y_i'	$y_i - Y_i'$	$(Y' - \bar{Y}')^2$	$(Y_i - \bar{Y})^2$
1.	5318957,7	5218065,681	101591,8646	1,21447E+13	1,1447E+13
2.	6387872,7	6572902,887	-184626,6091	4,53603E+12	5,35655E+12
3.	7862695,2	7820505,459	42259,3933	7,77675E+11	7,04927E+11
4.	9388092,1	9299276,456	88564,63345	3,56687E+11	4,70318E+11
5.	9841060,7	9901875,673	-61372,24197	1,44033E+12	1,29679E+12
6.	10273152,5	10257252,52	15019,82231	2,42063E+12	2,46759E+12
7.	11844232	11844472,65	-1436,861881	9,8808E+12	9,87177E+12
	$\bar{Y} =$ 8702294,7	$\bar{Y}' =$ 8702294,7	$\bar{u}_i = 0$	3,15569E+13	3,1615E+13

The fact that $\bar{u}_i = 0$, proves that the model is adequate.

The coefficient of determination will be:

$$R^2 = \frac{\sum(Y' - \bar{Y}')^2}{\sum(V_i - \bar{Y})^2}$$

$$R^2 = \frac{\sum(Y' - \bar{Y}')^2}{\sum(V_i - \bar{Y})^2} = (3{,}15569E{+}13)/(3{,}1615E{+}13) = 0{,}99816442 \approx 0{,}99 \text{ or } 99\%$$

Thus, it means that 99% of the variation of realized products (services) in the field of transport in Ukraine linearly depends on the distribution of the amount of material, investment and human resources. The remaining 1% of the variation of the realized products (services) of the transport sector in Ukraine can be presented in the form of other types of (non-linear) equations taking into account other influencing factors.

Since, of all the influencing factors under consideration, capital investments have the greatest influence on the increase in the value of realized products (revenue) in the field of transport, so it is advisable to build a paired correlation model between these parameters. With the help of Excel, we will graphically and analytically present the regression equation of the dependence of the value of the sold products (the ambassador) in the field of transport on capital investments (Fig. 2).
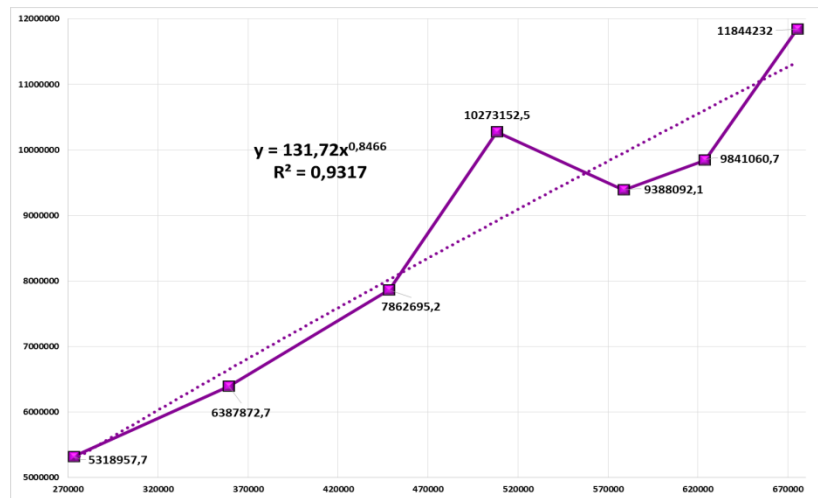

Fig. 2. Dependence of the value of realized products (services) in the field of transport on capital investments

Thus, it is possible to state that, other things being equal, a 93% variation in the number of products sold (services) in the transport sector of Ukraine can be represented in the form of a power function of dependence on the number of capital investments. Determining the structure of the national transport system becomes the starting point for developing and implementing transport strategies and understanding the components for the possibility of active regulation and control of the transport system in general and its members in particular. The structuring of the transport system is also necessary for building optimal international relations with international transport organizations and all other subjects of the world economy [5].

Gennadiy Ferdman notes that "The development and formation of the national transport system of Ukraine require effective state regulation of the activities of transport enterprises in the following main areas:

Improvement of regulatory and legal support and unification of transport legislation by international law;

- Creation of a system of interlobular transportation (production of specialized technical means-containers, interchangeable bodies, platforms for the vehicle of road trains);

 - Creation of the transport services market;

- Gradual renewal of rolling stock and production base;

- Ensuring transport safety;

- Activation of international activities of transport enterprises" [14].

3. Conclusion.

 In Ukraine, state policy in the field of transport needs to be improved. In particular, it is necessary to create conditions for effective control over the level of execution of their powers by executive authorities to ensure the functioning of transport. To fulfil the tasks defined by the National Transport Strategy of Ukraine for the period until 2030, in particular, to improve the collection and analysis system of statistical data regarding the development of transport in Ukraine. It is essential to conduct research to develop methodical approaches to assessing the relationships between the parameters of the transport potential. The proposed systematic approaches to the evaluation of the relationships between the parameters of the transport potential of Ukraine are based on the interpretation of the category "transport potential" by distinguishing its main parameters - resource provision and functioning results, between which there is a relationship, namely: the level of resource provision forms the functioning results. Resource support is proposed to be characterized by statistical indicators that reflect material, human, and investment resources and the consequences of functioning - by the value measurement of the volume of products sold by the type of economic activity "Transport, warehousing, postal and courier activities". A correlation dependence between the volume of products sold in the transport system and the corresponding indicators of resource provision has been proven. It has been proven that capital investments have the greatest influence on the increase in the value of the results of the functioning of the transport sector.

The functional form of the constructed correlation equations creates an economic-mathematical assessment of the real state of influence of material, human, and investment resources on the results of the functioning of the transport sector and also provides an opportunity to structure resources to achieve the desired result and form forecasts of the development of the transport sector. It is possible to develop further the proposed methodological approaches in the direction of developing mechanisms for stimulating the gradual modernization of Ukraine's transport system, which will be especially relevant at the stage of the post-war reconstruction of the country's infrastructure and economy.Separate groups of indicators in the rating assessment of the transport potential of the regions are proposed to be combined, taking into account their weighting factors, which are determined based on the distribution of the level of importance between the resulting indicators and resource provision in the field of functioning of the transport system of the region. The proposed methodical approaches and determined rating assessments of the transport potential of the regions of Ukraine make it possible to structure the resources of the national transport system by individual regions in the context of infrastructural support of the national production sphere.

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