Factor-criteria assessment of greening prerequisites for transport infrastructure development in Ukraine

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Abstract. The article examines the elements of factor-criterion assessment greening of the prerequisites for the genesis of the transport sector of Ukraine; in particular, the results of the evaluation of the evolution of the national transport industry. The methods of regulatory influence on the stages of the genesis of the national transport sector were studied, and the main problems of the evolution of the transport sector were systematized. It was determined that environmental protection of the transport sector is an important component of country's environmental security as a whole. The contribution of the «All-European program on transport, environment and health protection», which is implemented by the joint efforts of the UNECE and WHO, as well as the current regulatory and legal acts of Ukraine, which reflect modern trends in the integration of environmental policy into transport, are analyzed. In this model, there are international components of the sphere of service implementation, guidelines for defining goals and promising directions of greening, which will ensure the strengthening of the ecological component of the transit potential of Ukraine.

1. Introduction

The transport sector is an important link in the socio-economic development of the country. An important component of the transport system is the sustainable development of port-industrial associations. The study of the prerequisites for greening the development of the transport industry of Ukraine is relevant. Solving the issues of the formation of the transport system first of all requires a theoretical definition of the essence of the importance of greening the transport industry, as well as a study of its components.

The principle of integration of environmental policy into transport policy was reflected in official EU documents [1,2,3], as well as in UNECE and WHO documents [4,5]. In Ukraine, the integration of environmental policy is considered mainly as «greening».

The integration of greening has been used in Western countries since the late 1980s. Its appearance is due to the fact that traditional environmental policy and legislation in most cases cannot prevent pressure on the environment from the economic sectors.

At the pan-European level, the integration of environmental requirements into all areas of EU policy was first voiced at the European Council in Cardiff in 1998. Subsequently, the EU began to develop strategies for greening in sectoral policies, which were called the Cardiff strategies. First of all, integration strategies were developed for agriculture, energy and transport. In October 1999, the «Strategy for the Integration of Environmental Aspects and Balanced Development into Transport Policy» was adopted as part of the Cardiff Process [1].

In 2011, the concept of integrating environmental considerations into the transport industry was significantly expanded in the document «White Paper 2011» [2]

Regular monitoring of legislative and strategic initiatives is required to define any policy. One of the examples of monitoring progress in the field of integration of environmental and transport policies is the transport and environment reporting mechanism «Transport and Environment Reporting Mechanism» (TERM). This mechanism was developed by the European Environment Agency (EEA) and put into operation in 2000. Since then, annual reports have been prepared on the extent to which transport sector indicators contribute to progress in achieving the EU's environmental goals [3].

In Ukraine, the process of integration of environmental policy is considered mainly as a process of «greening», regarding the constant introduction of legal, economic, technical, management solutions to improve or preserve the environment.

The issue of greening the transport industry is only partially presented in Ukrainian legislation. In particular, the legislation «On transport» (No. 233/94-BP dated 10.11.1994) contains regulations on the protection of soils from the operation of vehicles. According to Article 11, transport companies are obliged to rationally use the land plots provided to them, not to violate the interests of other land users (including tenants) [6].

Conceptual foundations of state policy to ensure stable and effective functioning of the transport industry, increase the development of the economy and the standard of living of the population are provided by the «Transport Strategy of Ukraine 2030». Thus, in this order, it is determined that the level of transportation safety, the volume of energy consumption and the degree of environmental protection in Ukraine do not fully meet modern standards. About 90–95% of emissions of pollutants into the air of cities, in places of crowding, are caused by road transport [8].

2. Methodology

Today, the activities of the transport industry and the greening of logistics transportation are gaining significant importance for the economy of Ukraine. Using the experience of international logistics chains requires changes in the transport industry [7,8].

Accident reduction is a key component of safety in international logistics transportation. Taking into account the experience of other countries, international communication located at a considerable distance from large enterprises and urban areas is promising [9,10].

The presented scheme for increasing the environmental component of the country's transport complex (Fig. 1) contains international aspects of the genesis of the transport complex, the scope of its implementation, the problems of the formation of the transport industry, the ultimate goals of the implementation of greening and the necessary measures for the implementation of this program.

In addition to legal and organizational-technical decisions, the system of environmental safety must necessarily include a scheme for preserving the environment in places of transport routes.

To calculate the greening of enterprises in the transport industry, the following criteria {Ki} are considered, which form vector criteria K = {K1, K2 , ..., Ki}. Such K criteria are included in different groups of features.

For a comprehensive evaluation of the environmental impact of certain technological processes of transport infrastructure enterprises, the calculation of ecological processes was carried out.

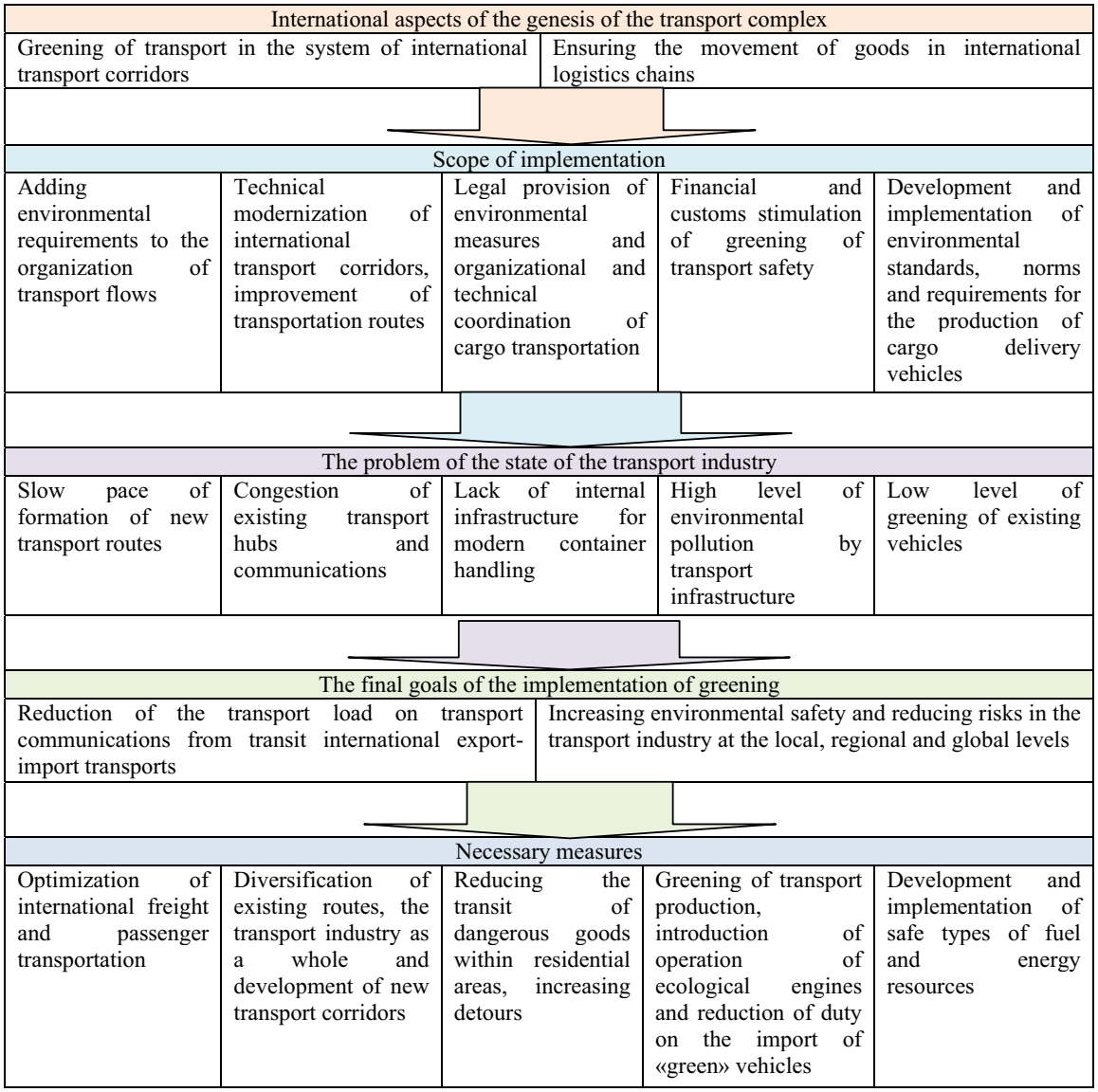

Figure 1. Scheme of increasing the environmental component of the country's transport complex

Thus, individual characteristics of expenses are summed up to general criteria Kce (1), Ke (2), Kwg (3):

$$Kce = \sum_{i=1}^{3} \beta i * \frac{Ei}{Eiб} \quad (1)$$

$$Ke = \sum_{i=1}^{4} \delta i * \frac{Ci}{Ciб} \quad (2)$$

$$Ke = \sum_{i=1}^{7} \gamma i * \frac{Bi}{Biб} \quad (3)$$

where Ei, Eib - the value of the level of the i-th criteria of energy consumption and resources of transport infrastructure enterprises; Ci, Cib - value of the i-th criteria level of transport infrastructure enterprises; Bi, Bib - value of the level and criteria of waste of transport infrastructure enterprises; weighting coefficients of costs, emissions, waste ($\sum\beta i = 1$; $\sum\delta = 1$; $\sum\gamma i = 1$).

Based on the characteristics of energy consumption Kve, emissions Kvsh and generation of waste Kvv, a deterministic indicator of environmentalization was formed, which has the form – Kes, has been formed, which has the form (4):

$$K_{ES} = \alpha 1 * Kce = \alpha 2 * Ke + \alpha 3 * Kwg \quad (4)$$

$\alpha 1$, $\alpha 2$, $\alpha 3$ – weight indicators of the component indicators of greening of enterprises in the transport industry ($\sum\alpha i = 1$)

The size of the weighting coefficients of the integral criteria of environmental safety was determined by the method of expert evaluations of the technological process of enterprises.

An indicator for evaluating the level of greening of transport infrastructure enterprises has been determined (Les) (5):

$$Les = \frac{1}{Kes} \Rightarrow 1 \quad (5)$$

Having considered various situational options, the value of the degrees of the level of environmentalization of the company is proposed (Table 1).

Table 1. Levels of greening of logistics enterprises

The level of environmentalization	The size of the differential indicator
General security	(1.00-0.80)
Reliable	(0.80-0.63)
Medium risk	(0.63-0,37)
Threatening	(0.37-0.2)
Especially threatening	(0.2-0.00)

Taking into account the developed criteria, the model for determining the level of greening of transport infrastructure enterprises was updated.

Thus, the methodology of the integral indicator of greening of enterprises in the transport industry was formed.

From the point of view of existing theoretical developments of a philosophical and general scientific nature, it is accepted to consider the previous conditions existing at the current period and in the past, as well as provisions and statements that are accepted as starting points in the process of further development.

One of the main factors that should be put into the basis of the process of determining the prerequisites for development are the existing problems that need to be solved and form the appropriate prerequisites for the development of systems.

Having conducted a study of the evolution of the transport infrastructure of Ukraine, we will list the main problems inherent in the transport industry. These include:

1. Insufficient elaboration of the normative and legal framework from the point of view of its compliance with modern realities. It is necessary to monitor the current legal field.

2. The presence of the problem of cross-subsidization of unprofitable transportation (for example, passenger transport). This problem is typical for a number of infrastructure enterprises. Its solution lies in the optimization of the system of redistribution of revenues of all transportation participants.

3. Low standard of competition in the transport industry (for example, railway transport and urban electric transport), which is due to the almost monopoly position of the operators of PJSC «Ukrzaliznytsia».

4. Inconsistency of the technical and technological state of assets, in terms of both rolling stock and stationary structures, with the needs of society and European quality standards. Obsolete rolling stock (vessels, wagons, planes) partly lead to the refusal of consumers to receive certain types of transport services.

5. The presence of manifestations of corruption at all levels of management and production processes - from the lack of transparency of service contracts to the transportation of illegal cargo and passengers.

6. Technical problems, in particular, wear and tear of fixed assets and sometimes outdated intangible assets, software.

7. Information and communication problems. This problem should include the weak presence of transport companies on the Internet, the inconvenient interface of company websites, the unsatisfactory quality of information and information and communication support (especially passenger transportation), etc.

8. Marketing and image problems. These problems should include insufficient advertising activity, sometimes unsatisfactory sanitary and domestic condition of means of transportation, in particular, passenger transport, permanent negative information emissions in the mass media, which significantly worsen the image of transport system operators.

The problems of the transport industry include: insufficient funding for the evolution of transport infrastructure, integrated both with global trends and with the demands of domestic consumers; presence of manifestations of inefficient management, sabotage of public-private partnership processes; incomplete load on port capacities due to reduction in freight volumes; manifestations of corruption in management and customs control; reduction in the number of qualified personnel for the maintenance of transport terminals due to non-competitive wages and other factors.

3. Results

The main stages of the basic genesis of the country's transport industry have been determined. The state and trends of the evolution of the country's transport system in the sphere of economic, legal, technological, social development and geopolitical and ecological integration are analyzed [10].

The analysis of statistical indicators regarding the development trends of the transport industry of Ukraine (Table 2) led to the conclusion of the following economic prerequisites:

- significant changes in the dynamics and structure of sea and river transportation, in particular, a significant reduction in cargo and passenger sea transportation. Annual transport shows an increase in freight turnover. This can be explained by the growth of both domestic and international (in particular, in the direction of EU countries) transportation;
- high transportation costs, which make up about 40% of the purchase price of goods and services, which leads to the economic impracticality of export-import operations;
- a significant decrease in the amount of investments in the evolution of water transport, which naturally leads to an increase in the part of morally and physically outdated assets of rolling stock and transport infrastructure. In 2021, there is an increase in the amount of money invested in the evolution of water transport almost to the level of 2015;
- a reduction of 36% of the total freight traffic compared to 2010 and 14% compared to 2015.
- 47% reduction in total passenger traffic, compared to 2010 and 52%, compared to 2015.

Also, statistical data show [12,13] that, according to 2021 data, there is a very high turnover of personnel (47.5%) at water transport enterprises with a rather low average salary (10,467 UAH per month), which negatively affects sustainable development this field of activity. The number of profitable enterprises does not exceed 75%, and the profitability of operating activities sometimes has negative values. The analysis of the maritime transport infrastructure directly made it possible to establish that Ukraine has a significant potential for the evolution of transport terminals and their communication routes.

Table 2. Volumes of transport services

Transportation services	2010	2015	2020	2021	2021 / 2010	2021/ 2015	Structure, 2021,%
Cargo transportation, thousand tons, including:	2210287,70	1644354,40	1478858,10	1415886,20	0,64	0,86	100,00
railway	360225,30	377318,30	267639,00	262633,50	0,73	0,70	18,55
marine	20797,80	3428,10	1892,00	2120,30	0,10	0,62	0,15
river	12844,60	2840,50	3698,00	3990,20	0,31	1,40	0,28
automobile	1816401,00	1260767,50	1205530,00	1147049,60	0,63	0,91	81,01
air	19,00	99,20	99,10	92,60	4,87	0,93	0,01
Transportation of passengers, th. of people, including:	4073930,50	3784256,70	2078011,50	1974116,20	0,48	0,52	100,00
railway	577431,50	425216,90	157962,40	154811,80	0,27	0,36	7,84
marine	7817,00	6642,00	71,90	79,40	0,01	0,01	0,004
river	3594,10	631,10	596,20	589,90	0,16	0,93	0,03
automobile	3483173,00	3343659,50	1906852,00	1804929,30	0,52	0,54	91,43
air	1914,90	8107,20	12529,00	13705,80	7,16	1,69	0,69
Capital investments in water transport, UAH million	-	253,70	198,20	252,40	-	-	-

Source: calculated by the authors based on data [11].

The total dimensions of cargo processing in the seaports of the country are shown in the Table 3.

Table 3. Sizes of cargo accepted by sea ports of the country, thousands of tons

№	Name of the port	Years					2021 / 2017
		2017	2018	2019	2020	2021	
1	Berdyansk	4450,80	3800,70	2397,80	1812,60	2074,20	46,60
2	Belgorod-Dnistrovskyi	715,70	462,93	352,41	235,45	117,26	16,38
3	Ishmael	4825,20	5682,62	5097,87	4683,29	4283,30	88,77
4	Chornomorsk	17257,56	15942,00	17225,20	21535,49	26153,00	151,55
5	Mariupol	8984,04	7603,50	6514,47	5887,86	6483,75	72,17
6	Mykolayiv	22232,61	22424,31	23534,80	29204,82	33432,93	150,38
7	Odesa	25585,85	25250,85	24136,58	25250,85	25343,62	99,05
8	Renee	906,93	972,37	1124,90	1332,65	1275,27	140,61
9	Skadovsk	37,90	32,90	20,90	8,40	4,70	12,40
10	Olbia	6911,11	6538,53	6880,46	2944,10	3097,20	44,81
11	Ust-Dunaysk	22,50	25,40	54,20	51,10	70,80	314,67
12	Kherson	4133,89	3712,23	3341,02	3074,68	3802,68	91,99
13	Southern	48582,07	39297,57	41897,83	42702,24	53862,51	110,87
14	In total	144646,16	131745,91	132578,44	138723,53	160001,22	110,62

Source: formed by the authors [14].

The analysis indicates a general increase of 10% in the volume of cargo handled by seaports of Ukraine in 2021 compared to 2017. However, during the specified period, the dynamics of growth is observed only in 5 ports: SE «MTP «Black Sea» SE «MTP «Pivdenny», SE «MTP «Mykolaiv», SE «MTP Reni», SE «MTP «Ust-Dunaisk». The analysis indicates a general increase of 10% in the volume of cargo handled by seaports of Ukraine in 2021 compared to 2017. However, during the specified period, the dynamics of growth is observed only in 5 ports: SE «MTP «Black Sea» SE «MTP «Pivdenny», SE «MTP «Mykolaiv», SE «MTP Reni», SE «MTP «Ust-Dunaisk».

Since multimodal deliveries take into account the transportation of transit cargoes, the total volumes of transit cargoes processed by the seaports of Ukraine (Table 4) and their share in the total cargo traffic were investigated (Table 4).

Table 4. Sizes of transit cargoes that are transshipped by sea ports, thousands of tons

№	Name of the port	Years					2021 / 2017
		2017	2018	2019	2020	2021	
1	Ishmael	1232,01	1314,01	1476,15	1014,76	620,27	50,35
2	Chornomorsk	2161,53	649,60	797,42	804,30	1014,02	46,91
3	Mariupol	8,30	0,00	0,00	0,00	0,00	-
4	Mykolayiv	1853,69	1090,50	1220,46	232,30	1,60	0,09
5	Odesa	3784,84	2553,91	2175,94	1301,62	1180,28	31,18
6	Renee	850,55	937,95	1092,41	1267,36	1262,47	148,43
7	Skadovsk	0,00	2,10	0,00	0,00	0,00	-
8	Olbia	742,64	225,43	251,43	48,84	7,06	0,95
9	Kherson	55,85	17,73	0,00	0,00	0,00	-
10	Southern	5214,83	3537,62	4788,40	5552,19	6938,84	133,06
11	In total	15904,24	10328,85	11802,21	10221,37	11024,54	69,32

Source: formed by the authors [1,14].

The analysis shows that only 7 seaports of Ukraine handle transit cargo. It should be noted that in 2021, compared to 2017, only 2 ports increased the volume of transit cargo processing: SE «MTP Reni» – by 48.43% and SE «MTP «Pivdenny» – by 33.06%.

In 2021, compared to 2015, the share of processed transit cargo was increased by 5.56% at the SE «MTP Reni», and by 20.02% at the SE «MTP «Pivdenny». Ports can be divided into unified, diversified and specialized ports according to the degree of coverage of types of cargo.

Unified ports evenly handle various types of cargo, have a wide range of equipment, developed transport infrastructure, active and stable business relations with all operators and companies working in the port. Today, only the State Enterprise «MTP «Odesa» can be considered such a port. SE «MTP «Mykolaiv» aims to become a multimodal hub of Southern Ukraine, but now it is a well-diversified enterprise with formed cargo groups [15]. Diversified ports are characterized by medium sizes and direct their activities to the processing of various cargoes. These include State Enterprise «MTP Mariupol» and State Enterprise «MTP Chornomorsk», State Enterprise «MTP «Reni» and State Enterprise «MTP «Mykolaiv». It is also expedient to distinguish these pits according to the following criteria: concentric diversification, which is based on the search and use of additional capabilities of the port, which are contained in the current technological process; horizontal diversification, which involves the search for growth opportunities at the expense of new services based on new technologies; conglomerate diversification, which allows expanding activities due to the provision of technologically unrelated services implemented in new markets.

Specialized (niche) ports actively develop the processing of a certain cargo or a group of cargoes that are produced or consumed in the adjacent territories. Such ports include: SE «MTP «Izmail» (specialization in coal and ores), SE «MTP «Kherson» (bulk cargo), SE «MTP «Bilhorod-Dnistrovskyi» (timber materials). The classification of ports according to the criterion of the volume of cargo processing allows them to be divided into leading (SE «MTP «Odesa», SE «MTP «Pivdenny», SE «MTP «Black Sea», SE «MTP «Mykolaiv»), medium (SE «MTP «Mariupol», SE Berdyansk MTP, Izmail MTP SE, Reni MTP SE, Kherson MTP SE) and those that slow down cargo handling volumes («Bilhorod-Dnistrovsky» MTP SE, «Ust MTP SE – Danube»). The economic results of seaports and terminals reflect a 30-40% underutilization of the available port capacities, which negatively affects the financial results of their activities. It is also determined that the technical and technological support of transport terminals lags behind global trends and the needs of ship and cargo owners. Domestic experts confirm this conclusion and note the unsatisfactory state of the infrastructure and auxiliary facilities.

Basic legal norms for formation effective and functioning of the national transport infrastructure e include:

1. Legal support of transport infrastructure (Laws, Statutes, Regulations, Transport Rules, contracts, instructions).

2. Regulation of the operational activities of the transport infrastructure (coordination of the work of all transport, preparation of traffic schedule, repair of rolling stock and repair base, acquisition of new rolling stock and equipment).

3. Legal support of financial and economic activities (property management, pricing policy, etc.).

4. Regulation of the social environment, personnel policy, environmental protection measures (recruitment, safety of working conditions, social protection, etc.).

5. Legal provision of international cooperation (prevention and prevention of offenses, protection of state secrets) [16].

However, the general legal regulation of the development of transport infrastructure is centralized and almost does not take into account the specifics of the regions. Normative and legal regulation also needs restructuring. Therefore, an important influence on the formation of the legislative framework for the development of the country's transport infrastructure is the process of legalization, which is the basis for institutional transformations. Including the «National Transport Strategy of Ukraine» till 2030 [17], the following are among the technological prerequisites for the development of transport infrastructure: the low level of development of transport and logistics technologies and multimodal transportation facilities, which reduces its competitiveness and limits the access of Ukrainian products to the world transport market; insufficient technical and technological support of service systems of Ukrainian sea trade ports and their absence in world rankings according to quality and manufacturability criteria; low rates of implementation of leading innovative technologies, technological and logistic trends, in particular, systems (no more than 0.5% of the transport market); low level of interoperability and general technological lag behind TEN-T (Trans-European Transport Network) [17], despite convenient location and availability of conditions for integration.

The following should be attributed to the ecological stage of the formation of the country's transport industry: the logistics market of Western Europe is almost completely formed and is considering growth prospects in the east, namely in Ukraine, which gives the domestic transport system significant priorities for development; the good location of the country allows forming the basis for using the opportunities of integration into Euro-Asian transport flows; expanding the geographical presence of global and European logistics companies provides opportunities for joint activities; the possibility of expanding the range of services and types of cooperation with international operators. The social evolution of transport infrastructure should include the following:

- a change in the mentality of citizens in the direction of using free time and vacations, namely an increase in demand for travel, tourism, etc.;
- absence of a visa regime from the EU and simplification of travel abroad for obtaining educational and medical services, forming business connections, labor migration, etc.;
- a gradual increase in the well-being of citizens and a significant decrease in the cost of consumer loans (as a result of the reduction of the NBU refinancing rate from 30% in 2015 to 13.5% as of the beginning of 2020), which leads to an increase in the demand for loans, in particular, for private vehicles, travel on credit, etc.

It is advisable to specify the specified prerequisites in order to obtain certain dimensions of the latter. The scientific basis of this process is the method of factor-criterion evaluation, according to which the qualimetric approach is used as the methodological basis of measurement («quali» – quality, «metric» - measure). The conducted analysis of scientific developments made it possible to establish that the application of the scientific basis of qualimetry for diagnosing the state of socio-economic systems makes it possible to obtain a wide range of assessments of its state from the point of view of the quantitative value of qualitative indicators [18]. The calculation of the factor-criterion evaluation should take place in two stages: assessment of the properties of the object, i.e. determination of factors affecting its development; evaluation of the composition of the determined properties.

At the same time, each factor and criterion must be assigned its weight within the entire evaluation system (for factors) and within the factor (for criterion). The method of expert evaluations can serve as a methodological basis for determining weight values, according to which experts evaluate the proposed objects using the scoring method (for example, on a 10-point scale). The direct assessment in points of each expert in the group of experts is subject to processing. On its basis, the weight or significance of the object in the chain of other objects can be calculated [18].

In mathematical form, a set of n objects and m experts is formed. Each expert assigns a corresponding score to each object. The average score, which determines the weight and importance of the object, is calculated according to formula 6:

$$Wi = \sum_{j-1}^{m} Xij \ / \ \sum_{i-1}^{n} Xij \quad (6)$$

where Wi – the weight of the i-th object; Xij – rating assigned to the i-th object by the j-th expert; i-1,n, n – number of objects; j = 1, m, m – the number of experts.

Note that the sum of the weights of all objects is equal to one:

$$\sum_{i-1}^{n} Wi = 1$$

As experts, it is necessary to choose such persons whose answers would ensure the distribution of ratings, i.e. the ratings of one phenomenon given by different experts would differ from others by the interval permissible for this study (with the provision of an appropriate level of correlation).

Let's emphasize that experts should have sufficient knowledge and experience in the issue and be unbiased in assessing this or that phenomenon. As a method of determining acceptable intervals of disagreement (or correlation level), we used the rank correlation method, which allows us to determine the degree of correlation of experts' positions and, as a result, the obtained estimates. Within this method, the Spearman correlation coefficient (p) is calculated according to expression (7) [19]. This method is used because it allows to simultaneously establish the degree of correlation of experts' positions and the presence of random answers due to the fact that the working hypothesis is that there is no correlation between the assessments of individual experts and the results of a sample survey. Next, the probability of validity of this hypothesis is established. That is, this method is characterized by a high probability of reliability compared to similar ones.

$$q=1-(6 \sum_{i-1}^{n} d_i^2 \ / \ n(n^2-1)) \quad (7)$$

where n – the number of objects; 1,i – object number; d_i – the squared difference in scores, calculated according to the following formula (8):

$$di = pi1 - pi2 \quad (8)$$

where p_{i1} – the assessment given by the first expert (the first group of experts) to that object; p_{i2} – the assessment given by the second expert (the second group of experts) to that object, etc.

The obtained correlation coefficient can be in the range from -1 to +1, provided that the hypothesis that there is no zero correlation between the assessments of individual experts is correct.

As experts in this study, specialists in this issue were chosen among scientists and workers of the transport industry of Ukraine. First of all, we determined the necessary number of people, which should consist of an expert group for carrying out a factor-criterion assessment of the prerequisites for the development of transport infrastructure. We consider the initial constant to be the standard requirements for the representativeness of the study, i.e. the permissible error of the estimate A with a probability of 75% should be within ±5% (Δ =0.05) [20].

With a probability of P = 75%, we consider the confidence coefficient t = 1.15. We assume a value of σ = 0.5 for the level of sample variance (σ) and calculate the required sample size (number of members of the expert group). Under the chosen conditions, the expert group should consist of:

$$n = \frac{t^2 * \sigma^2}{\Delta^2} = \frac{1{,}15^2 * 0{,}5^2}{0{,}05^2} = 132{,}25 \approx 130$$

So, in order to carry out a factor-criterion assessment with an acceptable error of 5%, the probability of which is 75%, we had the task of interviewing no less than 130 people.

In accordance with the specified methodical approach, we conducted a factor-criteria evaluation of the organizational, economic and ecological genesis of the national transport infrastructure (Table 5) based on some criteria, thanks to which we conducted an analysis of the evolution of the transport infrastructure.

Table 5. Factor-criterion assessment of the organizational, economic and ecological genesis of the national transport infrastructure

Factors	Validity factor	Criteria	Validity criterion	Score in points	Evaluation by weight
Economic	0.25	Tariff and dividend policy of the state	0.25	8	2.0
		Taxes and fees, instability of fiscal legislation	0.2	9	1.8
		Changes in economic and labor behavior of the population	0.25	7	1.75
		Investments in the development of transport infrastructure	0.3	8	2.4
		In general, according to the criteria			1.98
		In general, taking into account the weight			0.497
Legal	0.2	Decentralization of power	0.2	8	1.6
		Regulation of operational activities	0.3	7	2.1
		Legal support of financial and economic activity	0.2	7	1.4
		Regulation of the social environment, personnel policy, environmental protection systems	0.1	5	0.5
		Legal provision of international cooperation	0.2	9	1.8
		In general, according to the criteria			1.48
		In general, taking into account the weight			0.296
Ecological	0.2	Development of transport and logistics technologies	0.3	7	2.1
		Technological support of port service systems	0.4	8	2.4
		Implementation of leading innovative technologies, technological and logistics trends (multimodal systems)	0.15	6	0.9
		Interoperability	0.15	5	0.75
		In general, according to the criteria			1.53
		In general, taking into account the weight			0.306
Geopolitical	0.25	Development of EU environmental operators in Ukraine	0.05	5	0.25
		Assessment of the environment	0.6	9	5.4
		Development of compatible projects	0.1	7	0,7
		Expansion of the range of transport environmental services	0.1	6	0.6
		Multidirectional environmental vectors of transport infrastructure development	0.15	8	1.2
		In general, according to the criteria			1.63
		In general, taking into account the weight			0.4075
Social	0.1	Changing the mentality of citizens	0.4	5	2.0
		No visa regime with the EU	0.4	5	2.0
		The increase in the welfare of citizens and the decrease in the cost of consumer loans	0.2	4	0.8
		In general, according to the criteria			1.6
		In general, taking into account the weight			0.16

The obtained results show that environmental and economic factors are the most important. They are evaluated by experts almost equally. Technological and legal factors affect the development of transport infrastructure, but it is almost a quarter less than the previous factors. The social factor has the least influence.

The graphic visualization of the results of the factor-criterion analysis of the evolution of the transport infrastructure (Fig. 2) demonstrated which of the identified factors have the most significant influence.

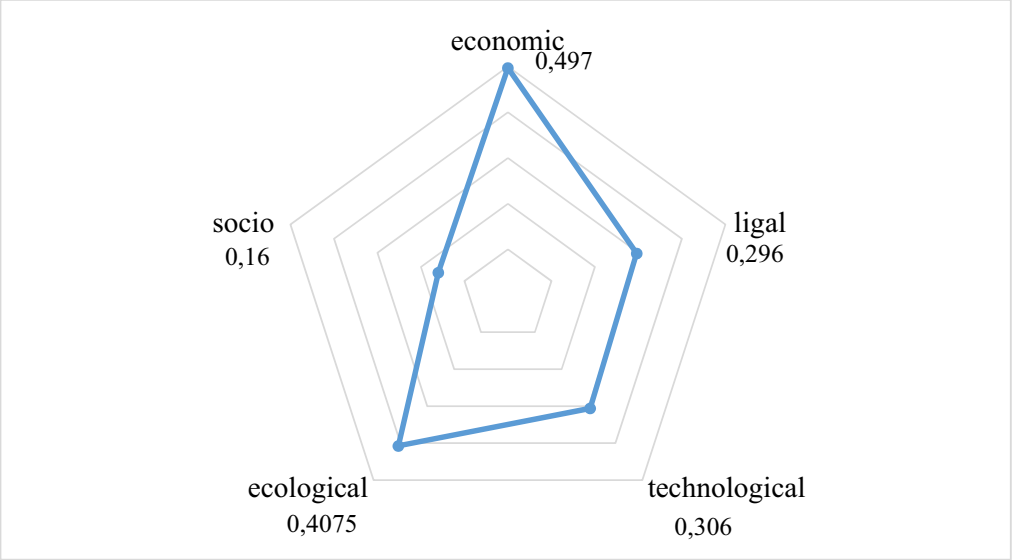

Figure 2. Visualization of the conclusions of the factor-criterion assessment of the genesis of the national transport infrastructure

After determining the quantitative assessment, it is important to move to the qualitative one and to form methodical approaches to the interpretation of the obtained results by forming the appropriate scale. In this way, we evaluate not only the degree of influence of factors, but also the limits, the violation of which can cause significant structural shifts in the overall system.

We have researched scientific works on methods and approaches to interpretation of results by forming a scale of intervals [21,22]. In many works, 0.5 is considered the limit level (with a rating from 0 to 1). This means that if the value of any indicator in the evaluation system is less than 0.5, its influence on the system is insignificant and vice versa. Other approaches are based on interval interpretation with a step of 0.1÷0.25, that is, a smaller estimate corresponds to a smaller influence of the indicator. Scientists have developed a non-linear scale for interpreting assessment results. Thus, in [23] developed a scale for evaluating the effectiveness of communication channels, which establishes the following intervals:

- from 0 to 0.45 ─ a low score, so the approaches to the operation of the object must be changed;
- from 0.45 to 0.75 ─ a satisfactory assessment, however, there is a need to update and modernize the object;
- from 0.75 to 0.9 ─ a good assessment, it is important to adapt the object according to the conditions of the situation;
- from 0.9 to 1 ─ an excellent rating.

The definition of limit the results of the factor-criterion evaluation of the evolution of the national transport infrastructure (Table 6) is that in this case, when the establishment of weight values is the basis for adjusting the obtained indicators depending on the degree of their influence, the usual interval scale can be used to interpret the obtained results (from 0 to 1) with a step of 0.2 [20].

As a result of the assessment, it was established that the environmental and economic factors that can affect certain strategic directions of the evolution of the national transport industry are the most noticeable, the social factor is rather weak.

Table 6. The scale of interpretation of the factor-criterion assessment of the prerequisites for the genesis of the national transport infrastructure

Evaluation interval	Meaningful filling
0-0.2	The influence of the factor is very weak, close to minimal
0.21-0.4	The effect is noticeable, but not significant
0.41-0.6	The influence is quite significant, it can determine certain strategic directions of system development
0.61-0.8	The impact is significant, capable of changing the principles and methods of system operation
0.81-1	The influence is maximum, it can lead to radical institutional changes in the activity of the system

Source: [20].

The results of the conducted research made it possible to draw intermediate conclusions, which indicate the absence of leading factors determining the development of Ukraine transport infrastructure. However, transport systems, sustainable development and operational efficiency are very important for the development of the state under difficult economic conditions. That is why it is important to highlight the components of the mechanism of the evolution of the transport sector of Ukraine and the mechanisms and sources of financial support for this development, which is what the following sections of the work are aimed at.

4. Conclusions

As a result of the conducted research, the problems of the evolution of transport systems have been sorted out, namely: insufficient development of the regulatory and legal framework from the point of view of its compliance with modern realities; presence of cross-subsidization of non-profit transportation at the expense of cargo; low level of competition on the market of some types of transportation, non-compliance of assets and services with the needs of consumers and global quality standards; presence of manifestations of corruption, wear and tear of fixed assets and obsolescence of intangible assets; insufficient information and communication support; marketing and image problems.

Prerequisites for the development of transport infrastructure, which include economic, legal, technological, ecological and social, were determined, and their factor-criterion evaluation was carried out. On the basis of the defined main criteria, we set their weight values by the method of expert evaluation and gave an estimate (in a point system) using a methodical approach. An interpretation of the results of the factor-criterion assessment of the prerequisites for the genesis of transport infrastructure is proposed, which consists in using a scale with parameters (from 0 to 1) with a step – «0.2». The calculations showed that none of the factors had an impact on the evolution of the system, which could lead to a change in the methodology of the country's transport infrastructure. It has been proven that the development of prospective studies, which cover the problems of transport development, the creation of international transport corridors and compliance with environmental requirements, will provide an opportunity to ensure environmental protection, fulfill the tasks of the sectoral sphere to the requirements of interstate transportation of goods in the light of integration into the EU, as well as guaranteeing the sustainable development of territories.

To reduce atmospheric air pollution by transport and other mobile vehicles and installations, as well as the impact of physical factors related to them, the development and implementation of a set of measures to reduce emissions, neutralize harmful substances and reduce physical impact during design, production, operation and repair of transport and other mobile vehicles and installations; transfer of transport and other mobile vehicles and installations to less toxic types of fuel; improvement of fuel transportation and storage technologies; ensuring constant control of fuel quality at oil refineries and gas stations, implementation and improvement of the activity of control and regulatory and diagnostic points and complex systems for checking environmental safety standards of transport and other mobile vehicles and installations.

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