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# Strategic planning for sustainable development from the standpoint of economic security on the example of the railway transport of Ukraine

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### ABSTRACT

The concept of strategic planning of sustainable development on the example of the railway transport of Ukraine from the standpoint of economic security, which includes methodology, methods and principles of research through the identification of the level of sustainable development, the definition of criteria, objectives and strategies for the modernisation of railway transport by using adaptive control techniques from control theory.

**Keywords:** strategic planning, modernisation, concept, sustainable development, economic security, integrated index, strategic landmarks, railway transport.

### 1. Introduction

The economic strategy, edited by S. Mocherny, contained in the economic dictionary, is “a long-term economic policy course that involves solving large-scale economic and social problems” [Mocherny, 1995]. In most of the strategy formulations, there is a mandatory presence of certain target benchmarks in the definitions for which the strategy should be targeted. For example, A. Chandler explicitly interprets the strategy as “determining the main long-term purposes and objectives of the organisation, the adoption of the course of action and allocation of the resources necessary for these purposes” [Chandler, 1962]. Thus, as J. Zhalilo rightly states, “goal setting is the starting point for the strategy formation” [Zhalilo, 2009]. Strategic planning is a detailed description of the purposes, objectives and a set of measures to implement the fundamental objectives of the strategy of economic security [Horbulin, Kachyns'kyj, 2010]. Therefore, the scientific substantiation of the quantitative

benchmarks of the Indicators of Development Strategies is necessary and relevant. Railway transport is one of the primary branches of the economy. Stable and efficient functioning of railway transport is a prerequisite for ensuring the defence capability, national security and integrity of the state, and raising the population's standard of living [Government of Ukraine, 2006]. A detailed analysis of the constituents of the sustainable development of railway transport suggests that railway transport (RT) is in a hazardous condition. On the one hand, there is a low level of renewal of fixed assets, share of wages in production, density of communications, electrification of railways, speed of movement, technical and technological backwardness of the infrastructure. On the other hand, at the same time, a high level of transport capacity of RT, shadowing of transport, wear of rolling stock, air pollution and final energy consumption create threats to the economic security of the country and stipulate the need for the reformation of RT.

## 2. Literature review and problem statement

Unfortunately, most of the strategies that were proposed in Ukraine up till now have determined the main areas and priorities of the Strategy implementation through declaring the necessary measures such as providing, enhancement, creation, formation, updating, implementation, improvement, attraction and development. Meanwhile, the definition of the priority areas of such strategies does not ensure the expected implementation of the targeted state policy, because it does not give clear, concrete results of the action – quantitative strategic indicators, monitoring which would allow controlling the development of certain areas. In other words, the definition of the areas and priorities of modernisation is a necessary, but insufficient condition. A striking example of this approach is the Transport Strategy of Ukraine for the period up to 2020 [Government of Ukraine, 2010]. That is why such a “declarative” approach does not give clear, concrete results of the actions – quantitative strategic benchmarks of the indicators, the monitoring thereof would allow controlling the development of certain areas. That is why the main conclusion of the national report “Innovative Ukraine 2020” is the statement that “...The final formulation of the priority areas should be determined by serious predictive and analytical research, as provided for by the law. Today, it is a half-intuitive vision of several specialists with whom the Verkhovna Rada of Ukraine agreed upon” [Heiets', 2015].

The works of both foreign and domestic scientists are dedicated to the research of problems of sustainable development of the regions of Ukraine [Zghurovskiy, 2006; Zghurovskiy, 2009; Pankratova, 2011; Novikova, Amosha, Antoniuk, 2012; Libanova, Khvesyk, 2014]

Despite the volume of the research, it should be noted that insufficient attention is paid to the scientific substantiation of the criteria of sustainable development, the methodology of integrated assessment of the level and strategic guidelines for sustainable development of the country, regions or types of economic activity.

The strategic vision of sustainable development first provides for the definition of what is the distance is the integral index from the point of sustainable development, or the social, economic and environmental components, from where the disproportions to their development arise. That is, it is desirable to determine the starting point and the endpoint for each component of sustainable development, on which the strategic vision of sustainable development depends. The ultimate point of sustainable

development is the need for clear criteria for achieving sustainable development, both on the whole and at the component level. Lack of such criteria results in the substitution of scientifically grounded strategic goals by the intuitive vision of several experts, which puts into doubt the achievement of sustainable development. Therefore, the scientific substantiation of the quantitative benchmarks of the components and indicators of the Strategies for sustainable development is necessary and relevant.

The primary purpose of the development of a system of indicators is the monitoring of sustainable development of the society, which should reflect all aspects of the CEE development of the regions or the country. Most indicators, instead of being relevant indicators, are absolute indicators that distort the real reality. The conclusions from such studies may lead to the implementation of “not those measures and not in that place”. Indicators are not always divided into stimulants (S) and de-stimulants (D), which leads to incorrect assessment results. Weights coefficients are determined expertly, which adds a certain proportion of subjectivity, or are generally taken equal to units that exclude the sensitivity of the economic system from the influence of various factors. There is no comparison of integral indexes with integral threshold values, which allows identifying the state of the CEE development. There is a need to improve the form of the integral index, methods of valuation, and methods of the formal definition of “dynamic” weight coefficients. Taking into account the significant changes in politics and in the external economic situation, which, after some time, lead to radical structural changes in the economy and changes in empirical estimates of econometric interconnections, the constancy of weighting factors throughout the period is inadequate and does not reflect reality. Pay attention to the methods of determining the vector of threshold values.

The purpose of the article is to provide a scientific basis for sustainable development criteria for identifying the current state and identifying the strategic orientations for the medium and long-term prospects for the country, regions and economic activities from the standpoint of security.

## 3. Methodology

Taking into account the importance of the balanced economic development, we can state that effective strategic planning of sustainable development of the country, regions or types of economic activity should be based on a combi-

nation of balanced development of economic, social, environmental and institutional components from the standpoint of safety of each component.

Thus, the concept of strategic planning of sustainable development should include the most priority areas of the development of the management object in a particular perspective and is, in fact, a scenario for achieving the purposes. Additionally, the concept defines the ways of transition from the current position of the control object to the desired one through the objectives set by the subject of management. Thus, the concept is a managerial structure that contains the general system representation of the ways of transition from the current position of the control object to the desired one.

The main conclusion of the UN report [United Nations Industrial Development Organization 2015] is that technologies can serve the achievement of goals in all three dimensions (economic, social, environmental), sustainable development, whose balance is one of the leading places among the problems of sustainable development of countries, regions or IED. Therefore, the precise coordination and balance of these three components, and on this basis development of the development strategy, is a task of extreme complexity [Zghurovskiy 2006; Zghurovskiy 2009].

Taking into account the above, we can propose the concept of strategic planning of sustainable

development of the country, regions or types of economic activity from the standpoint of security, which includes the following stages [Kharazishvili, Shevchenko 2017, pp. 27-43]:

1. Determination of the sustainable development structure.
2. Determination of the safe existence limits.
3. Identification of the sustainable development level.
4. Definition of imbalances of sustainable development.
5. Substantiation of strategic benchmarks for sustainable development.
6. Institutional measures.

*Determination of the sustainable development structure:* This stage involves detailing the components and their indicators, forming the dynamics of the indicators and their belonging to stimulants (increase of which is desirable).

Sustainable development is an integral characteristic of the state of the economic system, as the system includes a number of sub-systems – the most important, from the standpoint of the authors, of the interconnected structural components of the economic system development, which reflect the functioning of certain spheres of the economy: economic, social, ecological components, which includes 19 indicators for railway transport (Fig. 1) [Shevchenko, 2016, pp. 158-166].

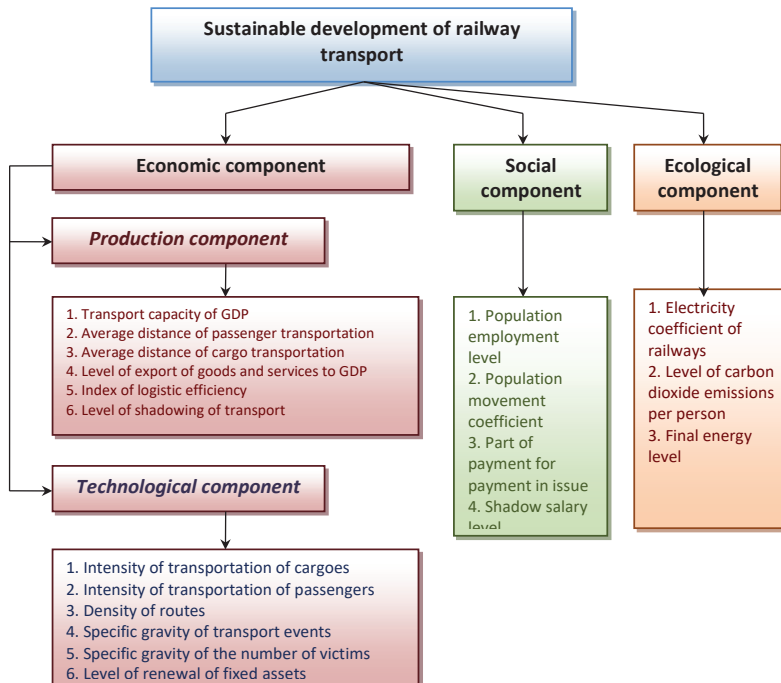


Figure 1. Components and indicators of sustainable development of the Ukraine railway  
Source: own study

The list of components and their indicators is not an example and may vary depending on the goals and depth of the research. It is not enough to analyse separate indicators or indicators of the development of railway transport. This does not give a complete picture of the state of sustainable development in general.

Determination of the safe existence limits. A systematic study of the problem of strategic planning of sustainable economic development should include a definition of the boundaries of the safe existence of the system; therefore, an essential stage in monitoring the state of the system is defining a vector of threshold indicators, which makes it possible to identify potential "danger zones" by comparing them, as well as determine the conditions for strengthening economic immunity of the studied system. The vector of threshold values involves the definition of lower and upper critical ( $x_{cr}^l, x_{cr}^{up}$ ), lower and upper threshold ( $x_{thr}^l, x_{thr}^{up}$ ), lower and upper optimal ( $x_{opt}^l, x_{opt}^{up}$ ) values of the indicators [Ministry of Economy of Ukraine 2007]. Taking into account the definition of the vector of threshold values, it is proposed to expand the "homeostatic plateau" [Dzh. Van Hyh 1981; Kachyns'kyj 2013] (Fig. 2) with the addition of a threshold zone and critical values of indicators.

On each side of the "homeostatic plateau," there are areas with neutral and positive feedback, the stay of which is dangerous or even threatens the existence of the system. In this sense, monitoring of the state of sustainable development as a

whole and the individual components and indicators for the establishment of the existing state in comparison with the thresholds, the definition of threats and the justification of the strategic guidelines are of great importance.

It should be noted that the intersection of the threshold or critical point does not take place momentarily until the type of inverse link is changed. Each dynamic system has its stability margin, so the type of inverse coupling is first reduced by the exponent, and then expanded exponentially, but with the second type of overbound link.

To determine the thresholds of the indicators of security, it is proposed to use the following methods [Kharazishvili, Dron', 2015, pp. 3-21] with the priority of their listing, namely:

- *Functional dependencies* (macro/microeconomic analytical or statistical equations; Akhiezer-Golts; theory of information; "golden section");
- *Macroeconomic models* that adequately reflect the effects of destabilising factors on the conditions of a particular country in the current period;
- *Stochastic* (diagnostics: cluster analysis, fuzzy sets; t-criterion; logistic regression);
- *Nonlinear dynamics* (wavelet analysis);
- *Legislative approach* (setting thresholds at the legislative level);
- *Heuristic* ("snowball"; analogue approach – orientation to indicators of analogue countries; "calibration");
- *Expert assessments*; taking into account evaluations of international organisations.

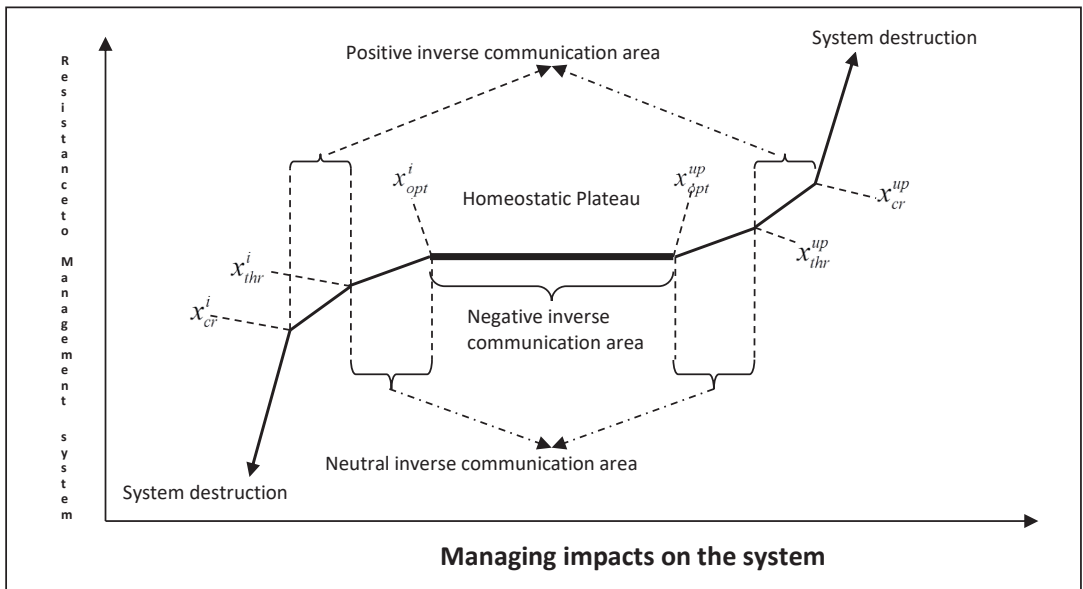


Figure 2. "Homeostatic Plateau" of the dynamic system  
Source: own study

The definition of threshold values is quite closely related to the concept of the dynamic stability of the economic system and its components, or with the mechanism of homeostasis. Without knowledge of the boundaries of safe conditions for the functioning of the economic system, it is impossible to protect its vital interests.

Therefore, the main task of ensuring sustainable development is not to maximise the level (integral index) of development, but to ensure its location within the thresholds, yet preferably optimal values (within the limits of the “homeostatic plateau”). If we seek to ensure that the integral development index is within the threshold or optimal values, this is accompanied by a violation of equilibrium and the emergence of new industrial relations that permanently change the previous state of equilibrium. At the same time, the economic system is transformed into a new state, endowed with the best qualitative characteristics. That is, in the process of development, not only the structure of the system (the composition of elements and connections), but also the relationship between the elements of the system and the mechanism of its functioning is changing. Therefore, homeostasis in the economic system determines not only the ability of dynamic stability for the existing mode of operation but also the ability to control – the transition to a new state of economic equilibrium, that is, the governance of the economic system [Amosha, Kharazishvili, Liashenko, Kvilinskyi, 2016, 19-34; Kharazishvili, Liashenko, Shamileva, Zhykhareva, 2016; Kharazishvili, Lyashenko, Zaloznova, Kvilinskyi 2016, 108-119; Kvilinskyi, Mieshkov, Bondaryeva, 2016, 13-19].

Consequently, as a criterion for achieving sustainable development, the average value of the „homeostatic plateau” is proposed for both individual indicators and their integral values.

Identification of the sustainable development level: The state of the economic system is described by several dozen of indicators, each of which can increase or decrease in separate periods. Therefore, there is a question: in which of the two periods considered its state was the best? If there are more than three indicators, the task is much more complicated, necessary formalised mathematical methods – an integrated assessment of the level of sustainable development with the definition of dynamic weight coefficients. Furthermore, failure to take into account the shadow aspects of the economic activity distorts assessments of development that are inadequate in reality.

The study of the methodological approaches to an integrated assessment of the state

of development or security revealed low deficiencies that lead to distorted assessments. Therefore, modern advances in the integrated assessment of the level of safety [Kharazishvili, Dron’ 2015, pp. 3-21] have been proposed and applied, namely:

A form of the integral index is multiplicative (1):

$$I_i = \prod_{i=1}^n z_{i,i}^{a_i}; \quad \sum a_i = 1; \quad a_i \geq 0, \quad (1)$$

where  $I$  – integral index;  $z$  – normalised indicator;  $a$  – weight factor.

Valuation method – combined (2):

$$S : z_i = \frac{x_i}{k_{norm}}, \quad D : z_i = \frac{k_{norm} - x_i}{k_{norm}}, \quad k_{norm} > x_{max}, \quad (2)$$

where  $x$  – indicator value;  $k_{norm}$  – normalizing coefficient.

Weighting factors - dynamic: based on the application of the “Main Components” method (3) and the “Moving Matrix” method (Yu. Kharazishvili);

$$C_i \times D_i = \begin{pmatrix} d_1c_{11} + d_2c_{12} + \dots + d_jc_{1j} \\ d_1c_{21} + d_2c_{22} + \dots + d_jc_{2j} \\ \dots \\ d_1c_{j1} + d_2c_{j2} + \dots + d_jc_{jj} \end{pmatrix} = \begin{pmatrix} w_1 \\ w_2 \\ \dots \\ w_j \end{pmatrix}, \quad a_i = \frac{w_i}{\sum w_i}, \quad (3)$$

where  $C$  – a matrix of absolute values of factor loads;  $D$  – vector-matrix of dispersions;  $c$  and  $d$  are elements of the matrices  $C$  and  $D$ ;  $w$  – the resultant contribution  $i$ -th indicator in the integral index;  $a$  – weight coefficients.

#### 4. Research results

Using the proposed approach, we obtain the dynamics of the integral index in comparison with the integral thresholds, which allows us to identify the state of sustainable development. It should be noted that the integral convolution is made not only for indicators but also for threshold values (Fig. 3, a).

Thus, the definition of integral indexes of the economic system and their comparison with the integral threshold values translate the concept of “development” into the concept of “security”.

*Definition of sustainable development imbalances.* Using the obtained dynamics of integral indices of components of sustainable development and basic threshold values, one can calculate the deviations of integral indices from their average optimal values, which can be considered as criteria for achieving sustainable development, which testifies to the disproportio-



nality of their development (Fig. 3, b). As each component and its indicators have their thresholds, the integral thresholds for each component will be different. The dynamics of deviations from their mean optimal values determines the importance of the threats to the components of sustainable development. This situation shows the ineffectiveness of the existing model of economic development and macroeconomic policy

on the whole. Thus, the establishment of a system of indicators for sustainable development and the introduction of monitoring of sustainable development, the main task of which is the collection and modeling of macro-indicators, calculation, valuation of indicators, definition of integral CEE development indexes and their deviations from the corresponding average optimal values will determine the development strategy.

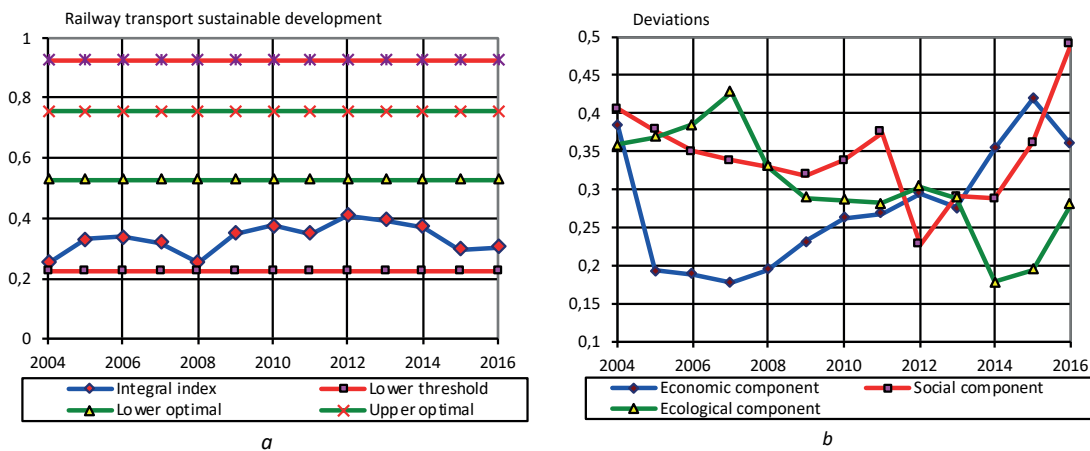


Figure 3. Dynamics of the integral index (a) and deviations of components of development from their average optimal values (b)  
Source: own study

Justification of Strategic Guidelines for Sustainable Development. The definition of the dynamics of the integral indices of sustainable development determines the necessary regulatory actions and enables the scientific substantiation of strategic benchmarks for different scenarios of development strategies. Upon receipt of the dynamics of the integral index of the state of the economic system, it is necessary to determine the strategic objective (or several goals, for example, for pessimistic, realistic, optimistic scenarios and sustainable development scenarios), depending on the ratio of the value of the integral index with integral threshold values that characterize the optimal, pre-crisis, crisis or the critical state of the economic system (Fig. 4, a).

At the same time we have the strategic tasks of eliminating the deviations of the integral indices of components of sustainable development from their average optimal values - that is, the criteria for achieving the level of sustainable development (Fig. 4, b). Knowledge of strategic goals causes the need to solve the problem of decomposition of the integral index, that is, the task of synthesizing the necessary

values of the components and their indicators for finding the integral index in the specified limits. Solving such a problem (inverse) for each component of sustainable development, when it is known (or given) its required value, allows taking into account the sensitivity of components or indicators, weight factors of influence and adaptive control methods [Kharazishvili, Dron' 2014, pp. 28-45] from the control theory to determine the necessary values of components and their indicators during the forecast period in each year.

Initially, such a procedure is carried out at the level of components of sustainable development, and then at the level of indicators of each component, that is, a consistent decomposition of the integral index is made, the result thereof is the scientific substantiation of strategic guidelines of key macro indicators that provide the desired level of development and are the basis for strategic planning of accelerated development of the country, economic activity or region of any level.

A generalized scheme of an adaptive system for regulating sustainable development with a reference model is given in Fig. 5.

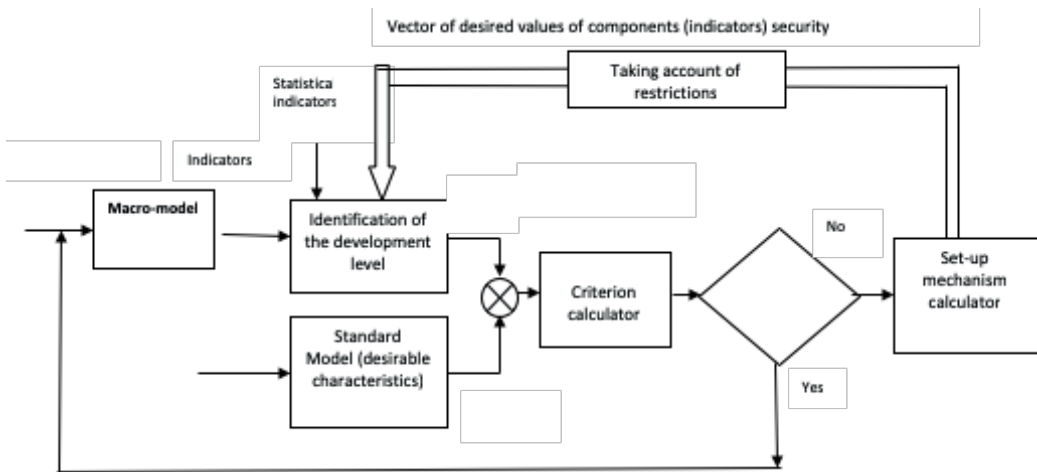


Figure 5. Generalised scheme of the adaptive regulation system  
Source: own study

Thus, the task of regulating the components of the integral index and their indicators is to determine their values in the aggregate to ensure that the values of the integral index are found within the given (threshold/optimal) values. Of course, the mechanism of setting parameters of the model uses methods based, in particular, on the error function gradient. The main principle of the tuning mechanism is the minimization of the quadratic error function and its derivatives, and it is assumed that all functions are continuous and at least twice differentiated (4):

$$F_t = (I_t - I_t^{sp.val})^2 = (I_1^{a_1} I_2^{a_2} I_3^{a_3} - I_t^{sp.val})^2 \quad (4)$$

We present the results of the strategic guidelines at the level of components of the development of the railway transport of Ukraine for various scenarios of development strategies (Table 1), which are obtained with the proposed approach – integral convolution of indicators and components of sustainable development, definition of strategic goals and adaptive regulation method [Kharazishvili, Shevchenko 2017, pp. 67-76].

According to the calculations, the preservation of existing developmental imbalances (Fig. 5, a) occurs when applying inertial scenarios of development under the current technical and

technological structure of the railway transport economy (which is characterised by weight factors of influence), that is, the equidistance of integral indices is not observed. Such disproportionality of development can be eliminated by a balanced scenario of sustainable development from the standpoint of economic security – the equidistance of integral indices of components of development from their average optimal values. Strategic benchmarks for sustainable development and its components, which are determined taking into account the sensitivity of the impact of each component on the integral index, are the goal of strategic planning for the medium to long-term.

Using the appropriate formulas for calculating indicators for each component of sustainable development and the valuation formula in reverse order, one can get strategic benchmarks for crucial indicators that, along with the strategic values of indicators, are the ultimate goal of regulating the sustainable development of railway transport. Ultimately, the level of deviation of actual integral indexes and indicators of functional components from their strategic values will determine the effectiveness or efficiency of the management of the implementation of the Ukraine railway.

Table 1: Strategic benchmarks for integral indices of sustainable development of railway transport at the level of separate components

Development components	Year				
	2016	2017	2018	2019	2020
<i>Realistic scenario (inertial)</i>					
Sustainable development	0.3033	0.3215	0.3396	0.3577	0.3757
Social	0.1394	0.1607	0.1820	0.2033	0.2244
Ecological	0.4575	0.4700	0.4834	0.4977	0.5127
Economic	0.3087	0.3195	0.3311	0.3434	0.3561
<i>Optimistic scenario (inertial)</i>					
Sustainable development	0.3033	0.3594	0.4154	0.4714	0.5272
Social	0.1394	0.2053	0.2703	0.3333	0.3944
Ecological	0.4575	0.4991	0.5477	0.6004	0.6291
Economic	0.3087	0.3446	0.3857	0.4298	0.4754
<i>Full Scenario (Balanced) – Sustainable Development</i>					
Sustainable development	0.3033	0.4391	0.5238	0.6085	0.6422
Social	0.1394	0.2629	0.3855	0.5080	0.6295
Ecological	0.4575	0.5011	0.5439	0.5868	0.6291
Economic	0.3087	0.3983	0.4883	0.5783	0.6688

Source: calculated by the authors.

According to the calculations, the most significant effect from sustainable development of railway transport in Ukraine will be obtained by applying a scenario of sustainable development – the equidistance of integral indices of components of development from their mean

optimal values. In the argument, it is advisable to show the dynamics of changes (increase, decrease) of indicators of sustainable development of Ukrainian railways for the period 2016-2020 for different scenarios of development (Table 2).

Table 2: Changing Indicators of Sustainable Development of the Railway Transport of Ukraine in 2016-2020

Index	Development Scripts		
	Realistic	Optimistic	Full-fledged sustainable development
1. Reducing the transport volume of GDP	0.9934	0.8951	0.6354
2. Reducing the average distance of cargo transportation	0.9636	0.7777	0.5282
3. Reducing the average distance of passenger transportation	0.9942	0.9062	0.6733
4. Increase in the level of export of goods and services to GDP	1.0022	1.0359	1.1320
5. Increase of the index of logistic efficiency	1.0041	1.066	1.2376
6. Reducing the level of shadowing of transport	0.9935	0.8938	0.6160
7. Increase in the intensity of cargo transportation	1.0005	1.0123	1.1263
8. Increase of passenger traffic intensity	1.0010	1.0264	1.2593
9. Increase in the density of communication paths	1.0022	1.0606	1.5479
10. Reducing the share of transport events	0.9984	0.9566	0.7777
11. Reducing the proportion of victims	0.9810	0.4791	0.2204
12. The level of renewal of fixed assets	2.0504	9.7389	32.524
13. Reducing the population employment rate in the RT field	0.9612	0.7734	0.4721
14. Increase in the mobility rate of the population	1.1316	1.8186	2.9788
15. Increase in the share of wages in the issue	1.0268	1.1944	1.5468
16. Reducing the level of shadow wage to the official	0.9032	0.6783	0.4046
17. Increase of the coefficient of railway electrification	1.0843	1.3377	1.3377
18. Reducing carbon dioxide emissions	0.9975	0.9975	0.9975
19. Reducing the level of final energy consumption	0.9229	0.7431	0.7431

Source: calculated by the authors.



Institutional measures. This stage involves developing and taking into account the institutional aspects of sustainable development: programming and policy planning, scientific developments, international legal instruments, information provision, strengthening the role of major groups of the population, etc. Knowledge of elasticity factors is important for conducting controlled influence on the condition of sustainable development of railway transport, which, due to weight components of components and indicators, explains the extent of influence of individual components and indicators and is the necessary information for the development of priority measures of influence.

The coefficients of elasticity of each component, which determine how many per cent change the initial value ( $y$ ) when the input value ( $x$ ) changes by 1 %, are calculated by the formula:

$$E = \frac{\Delta y}{\Delta x} \times \frac{x}{y} \quad (5)$$

According to the calculations, the coefficients of elasticity for the weight of the influence of the components of sustainable development of railway transport are as follows: ecological – 0,4682; economic – 0,2744; social – 0,2536. The coefficients of elasticity of individual indicators are given in Table 3.

Table 3: Elasticity Coefficients of the Sustainable Development Indicators

Indicators	$E$
1. Transport capacity of GDP. given t km per1 euro of GDP (D)	-0.0333 (9)
2. Average cargo transportation distance. km (D)	-1.25126 (2)
3. Average passenger transportation distance. km (D)	-0.03245 (10)
4. The level of export of goods and services to GDP. % (S)	0.0133
5. Index of logistic efficiency. % (S)	0.03361 (8)
6. Level of transport shadowing. % to GVA* (D)	-0.01522
7. The intensity of transportation of goods. mln t km per 1 km (S)	0.01996
8. The intensity of transportation of passengers. million passenger-kilometres per 1 km (S)	0.01996
9. The density of the routes. 1/km (S)	0.02243
10. Specific weight of transport events. per 100 mln t km (D)	-0.00001
11. The specific gravity of victims. per 100 million passenger-km (D)	-0.00038
12. Level of renewal of fixed assets. % (S)	0.01826
13. Employment rate (D)	-0.33244 (4)
14. Population mobility factor (S)	0.06214 (7)
15. The share of remuneration in the issue (S)	0.06339 (6)
16. The level of shadow wage to the official (D)	-3.12 (1)
17. Electricity coefficient of railways (S)	0.18578 (5)
18. Emission of carbon dioxide per person (D)	-0.02887
19. Final energy level (D)	-0.61297 (3)

Source: Calculations by the authors. Figures in parentheses indicate the ranking of indicators for the weight of influence.

The most serious threats to the economic safety of railway transport are indicators that are located on the priority of influencing its level of sustainable development:

1. Level of shadow wage to the official (social component).
2. The average distance of cargo transportation (economic component).
3. Level of final energy consumption (environmental component).
4. Level of employment of the population (social component).
5. The coefficient of railway electrification (ecological component).

6. The share of labour remuneration in the issue (social component).

7. The ratio of the population (social component).

8. Index of logistics efficiency (economic component).

9. Transport capacity of GDP (economic component).

10. Average distance passenger transportation (economic component).

Thus, the strategy of the development of railway transport in Ukraine should firstly be aimed at improving the state of these indicators of the economic safety of railway transport.

## 5. Conclusions

The concept of strategic planning of sustainable development of the economic system (on the example of the railway transport of Ukraine) from the standpoint of security has been developed, which includes the following stages: definition of the structure of sustainable development at the level of components and indicators, determination of the limits of the safe existence of the economic system, identification of the level of sustainable development, the imbalances at the constituent level, the scientific substantiation of the strategic benchmarks for sustainable development and development of the institutional measures. Identification of the sustainable development level is provided by the modern integral estimation of both indicators and their threshold values, which makes it possible to compare the dynamics of integral indexes with integral threshold values on a single scale. Thus, the definition of integral indices of the economic system and their comparison with integral threshold values translate the concept of “development” into the concept of “security”.

Defining of the vector of the threshold values of each indicator and their integral convolution makes it possible to propose the criteria for achieving the level of sustainable development, both in individual constituents, and in general for sustainable development through its definition as the average optimal value homeostatic plateau (the arithmetic mean between the lower and upper optimal values). Identifying of the level of the sustainable development, definition of integral thresholds values and criteria for achieving the level of sustainable development determines the ultimate goal and strategy of modernization by decomposing the integral index. This means the task of synthesizing the necessary values of  $c$  and their components and indicators to find the integral index within the specified limits by means of adaptive control methods from the control theory. The importance of the impact of indicators on the integral index of sustainable development of rail transport is calculated, and the main threats identified, as well as institutional measures need to be addressed.

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