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A. Shevchenko,
National Institute for Strategic Studies, Kyiv

IDENTIFICATION OF THE ECONOMIC SECURITY TECHNOLOGICAL COMPONENT OF UKRAINE IN THE FIELD OF RAILWAY TRANSPORT

Actuality of an issue. The economic security of Ukraine (hereinafter – EcS) in the transport sector as a part of national security [1, 2], describes the state of national interests protection of individuals, the economy, the state of the real and potential threats to quality transportation services to domestic and international transportation markets through effective use of the transport potential. Monitoring of transport infrastructure in the field of railway transport made it possible to determine the list of appropriate EcS indicators in the transport area as per functional components that directly affect the determination of country EcS in the transport sector and, consequently, economic security level of Ukraine in general [3]. The possibility of EcS integral evaluation in the field of railway transport in terms of economic functional component [4] caused the paper writing about the need for research in context of technological component.

Analysis of recent research and publications. Papers of many scientists are devoted to research of methodological approaches to integrated evaluation of EcS. O.S. Vlasyuk [5], V.M. Geyets [6], B.V. Gubskiy [7], J.A. Zhalilo [8], V.I. Muntiyan [9], S.I. Pirozhkov [10], Y.M. Kharazishvili [11, 12], V.T. Shlemko [13] and others has paid attention in their work to EcS problems and principles for its assessing. In the works these researchers examined methodological basis of analysis EcS in modern terms, concepts and models to ensure its most important components, analyzed threats and measures designed to enhance EcS. In Y.M. Kharazishvili, V.I. Lyashenko [14] work there was focused attention on development of Ukraine regions infrastructural, motor vehicles and rail transport indicators, and unfortunately there is no research in the context of the country, there are no indicators that reflect the EcS technological component in the field of railway transport. A.M. Novikova in the paper [15] drew attention to the fact that the technological component of transport includes only road safety, providing qualitative and quantitative properties of the cargo during transport operations and storage during transportation.

Existing Guidelines on the calculation of economic security of Ukraine [2] does not take into account the transportation component in determining the integral index of economic security and have certain shortcomings [16]. Also calculation method of regional economic development integral index has disadvantages [16, 17].

Purpose of the article is identification of EcS technological component in the field of railway transport through integrated assessment using integral index multiplicative form, which was proposed in the article of the author [4].

Presentation of basic material of the research. EcS level in the field of railway transport is characterized by many indicators, so you need to apply integrated assessment indexes that would describe this level of change in the plane of such components as economic, technological, social, environmental [4].

The set of EcS technological component indicators in the field of railway transport is given in table 1.

Table 1

Indicators of EcS technological component in the field of railway transport

Name of indicator, *unit*	Year												
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Intensity of freight transport (k1), *mln.tkm per 1 km*	10,63	10,18	11,00	12,00	11,86	9,05	10,05	11,26	10,99	10,36	10,00	9,27	8,93
Intensity of passenger transportation (k2), *mln. passenger-km per 1 km*	2,350	2,393	2,432	2,427	2,448	2,229	2,315	2,347	2,280	2,265	1,710	1,714	1,764
Density of routes (k3), *1/km*	0,039	0,039	0,039	0,039	0,038	0,038	0,038	0,038	0,038	0,038	0,037	0,037	0,037
Specific indicator of the number of traffic accidents to the volume of cargo transportation (k4), *per 100 mln. tkm*	0,474	0,436	0,370	0,336	0,332	0,418	0,375	0,314	0,321	0,321	0,321	0,322	0,322
Specific indicator of the number of victims to the volume of passenger traffic (k5), *per 100 mln. passenger-km*	0,416	0,488	0,387	0,450	0,332	0,271	0,239	0,248	0,237	0,189	0,286	0,400	0,400
The level of renewal of fixed assets (k6), *%*	5,593	5,898	4,344	5,018	2,213	0,884	0,353	0,480	0,554	0,135	0,094	0,096	0,101

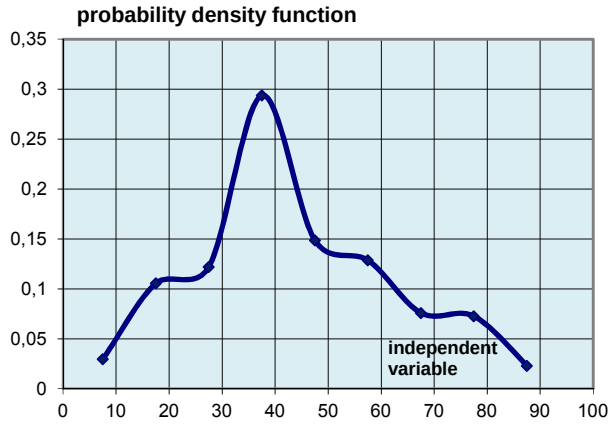
* *Author's calculations.*

We will identify the level of EcS technological component in the field of railway transport using multiplicative form of integral index, combined valuation method (via association for standardization and reference values for the "scale of variation"), "main component" method for a formalized approach to determining the weighting coefficients, the method of "moving matrix" to determine the dynamic weights and complex techniques to ground thresholds vector, including "t- criterion" [11, 16, 18-21].

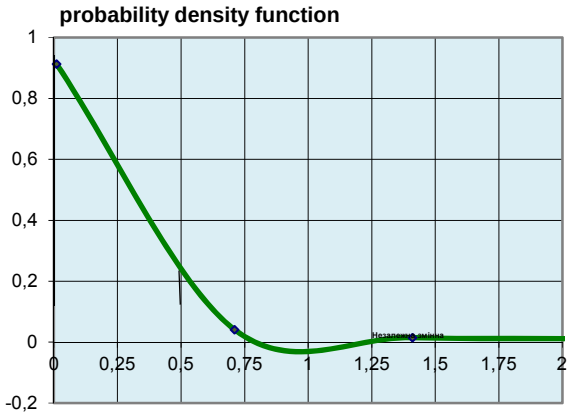
These indicators in Table 1 can be divided into two groups:

– with normal distribution – k2, k3 (fig. 1, *a*);

– with exponential distribution law – k1, k4, k5 (fig. 1, *b*).



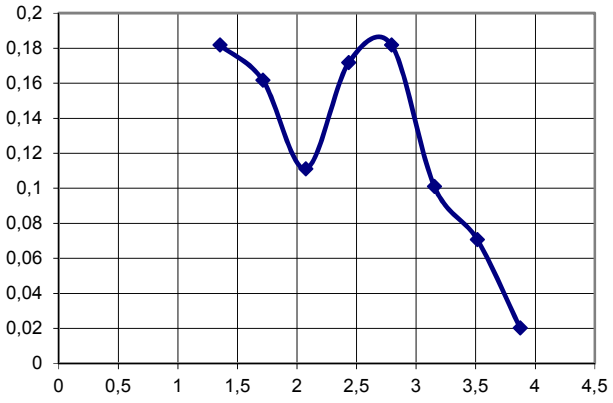
a



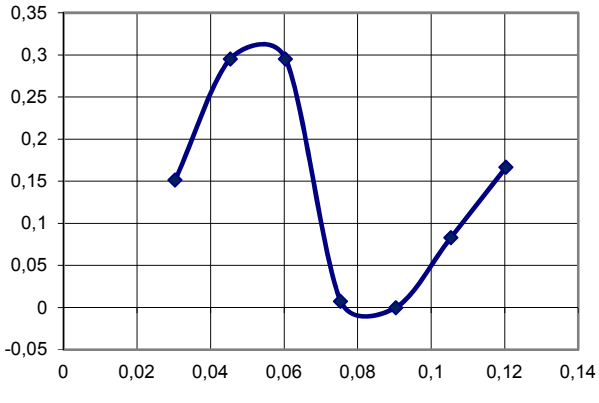
б

Fig. 1. Characteristic feature of the density indicators probability

When building density function of probability indicators to justify the vector of thresholds in addition to standard deviation there was applied these asymmetry factors: for k2 - 1,351 (Fig. 2, a), for k3 - 1,438 (Fig. 2, b), for k1 - 1,701 (Fig. 2, c) for k4 - 2,835 (Fig. 2, d), for k5 - 3,280 (Fig. 2, e.).



a



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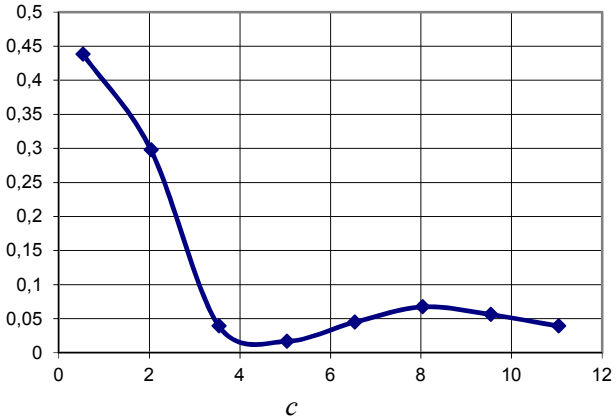

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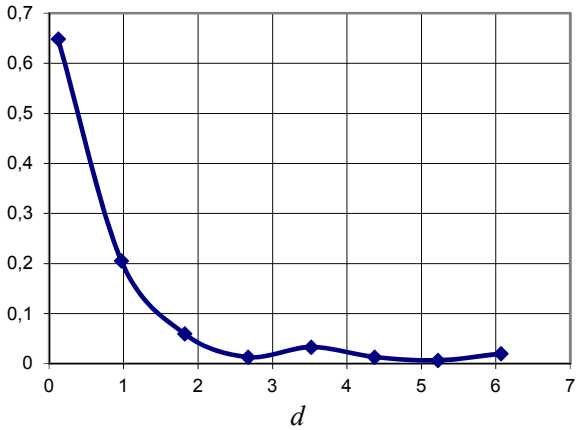

d

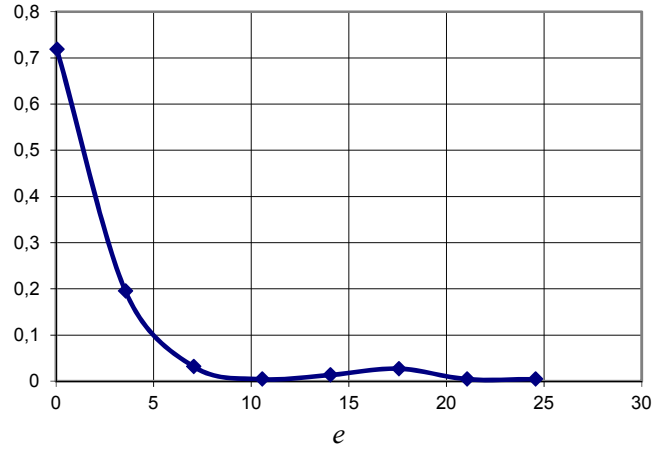

Fig. 2. Probability of EcS technological component indicators density function

The calculation results of threshold indicators vector are based on the experience of developed European countries, as well as their normalizing factors listed in the table. 2.

Table 2

Normalizing and optimal threshold value indicators *

Indicator, *units*	Normalizing indicators value	Lower threshold $y^{н}_{пор}$	Lower optimal $y^{н}_{опт}$	Upper optimal $y^{в}_{опт}$	Upper threshold $y^{в}_{пор}$
k1, *mln.tkm per 1 km* (stimulant)	14,5	2,7	5,5	9,0	14,5
k2, *mln. passenger-km per 1 km* (stimulant)	4,2	1,8	2,3	3,0	4,2
k3, *1/km* (stimulant)	0,135	0,025	0,045	0,085	0,13
k4, *per 100 mln. tkm* (destimulant)	6,85	4,2	2,0	0,75	0,32
k5, *per 100 mln. passenger-km* (destimulant)	27,0	12,5	6,0	1,9	0,05
k6, *%* (stimulant)	10,0	2,0	4,0	6,0	10,0

* *Author's calculations.*

Different dimensions and indicators of different orientation lead to the necessity of the indicators standardization procedure is performed using the combined method [21]. Results of the indicators valuation for normalizing the only factor is listed in the table 3.

Table 3

Indicators of EcS technological component after normalization *

Indicator	Year												
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
k1	0,733	0,702	0,759	0,828	0,818	0,624	0,693	0,776	0,756	0,714	0,689	0,640	0,616
k2	0,560	0,570	0,579	0,578	0,583	0,531	0,551	0,559	0,543	0,539	0,407	0,408	0,420
k3	0,290	0,290	0,289	0,289	0,286	0,286	0,286	0,286	0,286	0,285	0,277	0,276	0,277
k4	0,931	0,936	0,946	0,951	0,952	0,939	0,945	0,954	0,953	0,953	0,953	0,953	0,953
k5	0,985	0,982	0,986	0,983	0,988	0,990	0,991	0,991	0,991	0,993	0,989	0,985	0,985
k6	0,559	0,590	0,434	0,502	0,221	0,088	0,035	0,048	0,055	0,014	0,009	0,009	0,010

* *Author's calculations.*

In order to identify the safety state, we perform standardization procedures and integral convolution in the same scale as for the indicators and for the threshold.

As it was noted, [4] the main problem of integrated indicators use is adequate definition of weights devoid of subjective peer review, therefore, will use the method of "moving matrix" [11] to determine the dynamic weighting coefficients. The picture of indicators weighting coefficients changes is shown in fig. 3.

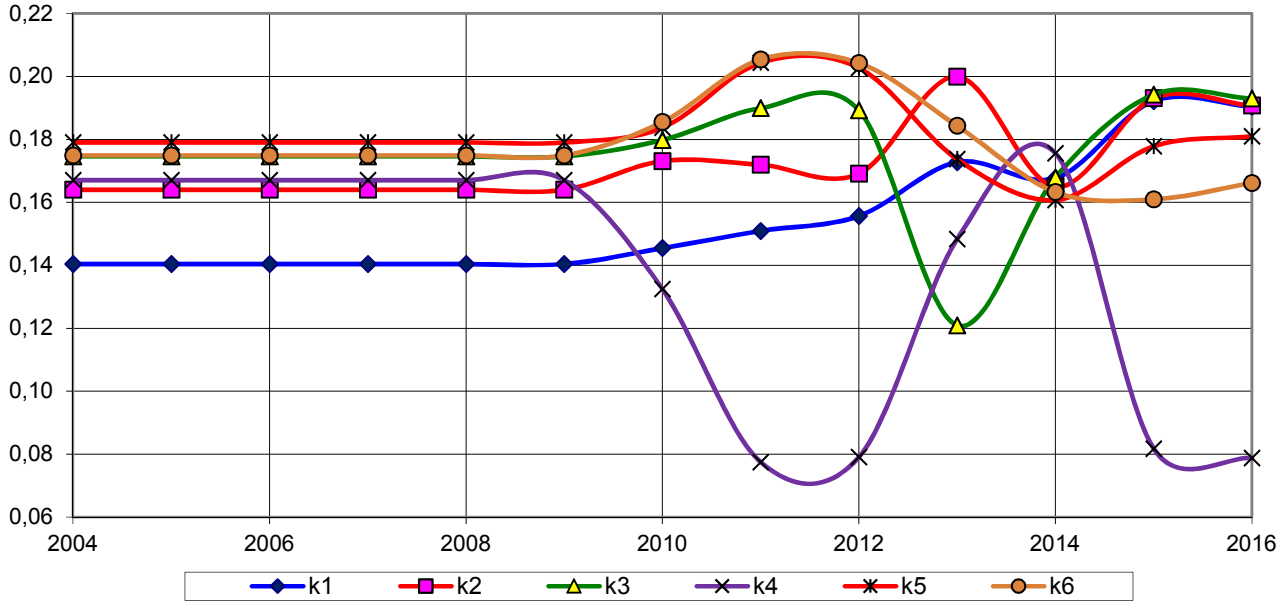

Fig. 3. Dynamic EcS technological component indicators weights

The constancy of weighting coefficients in the initial period (from 2004 to 2009) is due to the minimum necessary size matrix, which is determined as " accelerating period." The results of calculation dynamic series integral index of EcS technological component and integral index thresholds for the multiplicative form is given in the table. 4, 5.

Table 4

Dynamic range of the integral index *

Integral index	Year												
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
$I_t^{техн}$	0,624	0,628	0,605	0,628	0,544	0,438	0,364	0,366	0,375	0,322	0,302	0,283	0,279

* *Author's calculations.*

Table 5

Integral index thresholds *

Lower threshold $y_{пор}^{н}$	Lower optimal $y_{опт}^{н}$	Upper optimal $y_{опт}^{в}$	Upper threshold $y_{пор}^{в}$
0,2901	0,4958	0,7176	0,9857

* *Author's calculations.*

Using of s single normalizing factor to "process" indicators and thresholds lets compare the dynamics of integral index with thresholds in one scale. Changing the integral index of EcS technological component in the dynamics is shown in fig. 4.

Calculations of EcS technological component integral index in the railway industry indicate positive economic growth only for a short period of time; from the second half of 2008 this figure was in the range between the upper threshold and upper optimum values, but in 2014 crossed the «critical» line, indicating the real danger. This picture requires some justification.

The intensity of freight transport and passenger transport volumes determined by the ratio of the length of the routes. [22] These indicators show the intensity of the railways operation. Railways workload is used during planning of transportation process, determining the carrying capacity of the railways, working-out of measures for the development and technical reconstruction of railway lines.

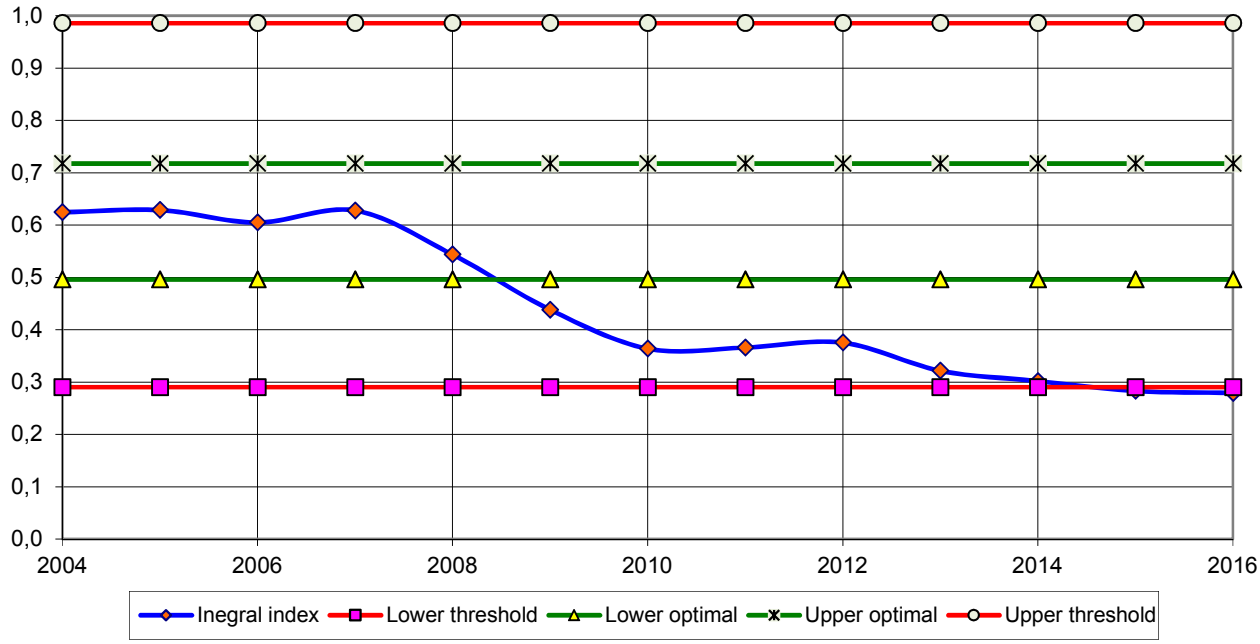

Fig. 4. Dynamics of the integral index of EcS technological component

The best indicator of the intensity of freight transport among developed European countries (Table 6) is due to the fact that Ukraine ranks fourth on the Eurasian continent in terms of freight traffic, being behind only China, Russia and India. [23] It should also be borne in mind that railway transport in Ukraine as a leading industry in the road transport sector provides 82% of the country's freight and almost 50% of passenger transportation carried by all modes of transport.

As a result of traffic accidents on the railways of Ukraine almost 95% were classified as incidents, the rest were classified as serious incidents. [24] Among all traffic accidents 35.4% happened due to defective repair of locomotives in depot conditions and through the operation of traction rolling stock and its equipment outside the warranty period of service; 11.1% - in the wrong actions of the locomotive and repair crews, 7% - through failure and rejection in the braking equipment in cars warranty period; 5.6% - due to heating of axle unit cars.

The calculation results of mathematical expectations intensity of freight transport (k1), the intensity of passenger transportation (k2), the density of routes (k3), the specific index number of traffic accidents to the volume of cargo transportation (k4) and specific indicator of the number of victims to the volume of passenger traffic (k5) are given in table 6.

Table 6

Mathematical expectation of EcS technological component indicators in the field of rail transport in Ukraine and the EU (2004-2015)*

Country	Indicators				
	k1	k2	k3	k4	k5
1	2	3	4	5	6
Ukraine	10,561	2,2421	0,0385	0,3607	0,3155
Germany	2,7070	2,1181	0,1136	0,5442	0,4038
Czech Republic	1,5405	0,7340	0,1235	1,0052	2,2523
Italy	1,2868	2,8116	0,0561	0,6175	0,2902
Austria	3,4405	1,6822	0,0704	0,4876	1,0062
France	1,1940	2,8145	0,0555	0,4839	0,1488
Spain	0,7515	1,6319	0,0278	0,7950	0,4051
Portugal	0,8843	1,4470	0,0297	2,5206	1,5512
UK	1,3272	3,4343	0,0664	0,4175	0,1271
Denmark	0,6862	1,9798	0,0741	1,1302	0,3843
Switzerland	2,3239	3,4316	0,1289	0,5734	0,3429
Ireland	0,0791	0,9196	0,0277	2,2092	0,1138
Slovenia	2,9000	0,5746	0,0606	0,8914	3,6364

Ending of Table 6

1	2	3	4	5	6
Finland	1,6530	0,6463	0,0194	0,4132	0,5700
Sweden	1,9824	0,9887	0,0269	0,3010	0,3646
Croatia	0,9835	0,4893	0,0479	1,8682	4,2195
Norway	0,8565	0,7653	0,0109	0,6448	0,2046
Poland	2,5402	0,8888	0,0659	1,4643	2,8482
Hungary	1,2205	1,0599	0,0832	5,2061	2,5719
Slovakia	2,3950	0,6656	0,0756	2,7445	3,5828
Bulgaria	0,9883	0,5097	0,0372	1,6105	3,5946
Lithuania	7,6500	0,1490	0,0275	0,4642	15,783
Latvia	9,5360	0,3871	0,0320	0,2236	5,1894
Estonia	6,0758	0,2197	0,0186	0,5170	9,1746
Romania	1,3161	0,5692	0,0468	1,7992	4,3032

* *Author's calculations.*

Conclusion

1. In order to identify the EcS technological component in the field of railway transport there is list of indicators that characterize specific areas of economic activity, namely the intensity of freight transport, intensity of passenger transportation, density of routes, specific indicator of the traffic accidents number to the volume of cargo transportation, specific indicator of the number of victims to the volume of passenger transportation.

2. Integral evaluation of EcS in the field of railway transport in the context of technological component held by modern methodology (using multiplicative form an integral index, combined method of rationing by association for standardization and reference values as per "scale variation", method of "main component" for a formalized approach to determine the weights method of "moving matrix" to determine the dynamic weights and complex techniques to study vector threshold, including "t-test").

3. The results of analysis of each EcS technological component indicator compared with those of developed European countries show a positive economic development (notably in the case of intensity of freight transport, where Ukraine has the best rate in the EU), but in 2014 the figure crossed the «critical» line, indicating the real danger.

4. Further operation of locomotives with expired deadlines of capital and current repairs (including the fact that 73% of electric and diesel locomotives have expired service), cars in excess of the regulatory period and the lack of normal reproduction of fixed assets (particularly their active parts - rolling stock) can lead not only to increase the specific rate of traffic accidents. There is a real threat of failure by rail in the future of the economy in Ukraine transport.

5. The task of regulation EcS technological component in the railway industry and its indicators is to determine the values of these in total to ensure the continued value of the integral index within optimal values by using the methods of control theory.

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Шевченко А. І. Ідентифікація рівня технологічної складової економічної безпеки України у галузі залізничного транспорту

Проведено інтегральне оцінювання рівня технологічної складової економічної безпеки України у галузі залізничного транспорту за сучасною методологією. Розраховано нормувальні, порогові, оптимальні значення, вагові коефіцієнти, а також математичні очікування індикаторів.

Ключові слова: вагові коефіцієнти, економічна безпека, індикатори, інтегральний індекс, математичне очікування, нормування, транспорт.

Шевченко А. И. Идентификация уровня технологической составляющей экономической безопасности Украины в сфере железнодорожного транспорта

Проведено интегральное оценивание уровня технологической составляющей экономической безопасности Украины в сфере железнодорожного транспорта по современной методологии. Рассчитаны нормировочные, пороговые, оптимальные значения, весовые коэффициенты, а также математические ожидания индикаторов.

Ключевые слова: весовые коэффициенты, экономическая безопасность, индикаторы, интегральный индекс, математическое ожидание, нормировка, транспорт.

Shevchenko A. Identification of the economic security technological component of Ukraine in the field of railway transport

There was conducted an integral evaluation of the technological component of economic security of Ukraine in the field of railway transport using modern methodology. There were estimated normalizing, threshold, optimum values, weighting factors and expectation indicators.

Keywords weighting factors, economic security indicators, integral index, mathematical expectation, regulation, transport.

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