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Research paper

Evaluating the rail transport resource potential development level

L. L. Kalinichenko [1] *, O. M. Chupyr [2], N. V. Yanchenko [3], V. M. Bredikhin [3], Ye. O. Burlaka [4]

[1] Department of Economics, Kharkiv National University of Building and Architecture, Kharkiv, Ukraine
[2] Department of Management and Public Administration, Kharkiv National University of Building and Architecture, Kharkiv, Ukraine
[3] Department of Economics, Kharkiv National University of Building and Architecture, Kharkiv, Ukraine
[4] Department of Finance and Credit, Kharkiv National University of Building and Architecture, Kharkiv, Ukraine
**Corresponding author E-mail: burlaka89@ukr.net*

Abstract

The rail transport enterprises resource potential ensures the financial activity success, higher competitiveness and is the basis of economic growth. As the resource potential is dynamic, it needs to be managed. The effectiveness of such management needs a full and reliable evaluation of country's rail transport resource potential development level. The objective of the work is to study the approaches to evaluate the enterprises resource potential development level and to offer a proprietary technology on the basis of the final index for the rail transport enterprises of any country. The object of research is the resource potential of the rail transport enterprises. The methodological basis of the research is the fundamental provisions of management, the results of scientific research in the field of enterprises resource potential development to evaluate its level of development. The analysis of existing methods for evaluating the enterprises resource potential development level resulted into the technology for evaluating the level of development of the country's rail transport enterprises resource potential by defining an integral index via hierarchy analysis method to determine the proportion of each component of the resource potential and to interpret the values of the integral index on the basis of Harrington verbal-numeric scale.

Keywords: *Development Management; Integral Index; Hierarchy Method; Rail Transport; Resource Potential.*

1. Introduction

Rail transport occupies a leading position in the economic complex of each country, providing the needs of social production and country's population in domestic and international transporting domestic. Territorially, the railway transport of Ukraine combines 6 railways and about 130 enterprises serving the railway infrastructure. Route miles are 19,790.9 km. There are 1,492 railway stations, 55 locomotives and 48 car depots, 110 railways divisions, 69 signaling and communication divisions, and 44 power supply divisions. All these facts testify of the rail transport strategic importance for the national economy.

The Ukrainian railway occupies one of the leading places on Eurasian continent for the routes length (the 4th place after Russia, China and India) and of cargo and passengers traffic volumes. The comparison of Ukrainian railways performance index to other countries' railways performance is presented in the Table 1 [26 - 31].

However, nowadays, Ukraine's rail transport is in a crisis owing to the outdated property assets, the non-electrification of a significant part of the tracks, the low average speed of travel, nonconformity of the railways and railheads to the European standards (Tokmakova, 2016).

These arise the necessity for efficient management of rail transport enterprises of Ukraine, in particular, their resource potential. This will influence not only the development of Ukrainian railway industry enterprises, but also the Ukrainian economics as a whole, as the rail transport is one of the most important components of the country's industrial complex.

Table 1: Comparing the Rail Transport Activity in Different Countries [26 - 31]

Country	Population 2017 (mln people)	Route miles (2017), km	Rout density per 1000 km² of the area (2017)	Cargo turnover, mln tkm net (2017)	Passanger turnover, mln pass.-km (2017)
Ukraine	42.386	19 790.9	32.78	191 914.10	28 001.3
Poland	38.623	19 214	61.45	54 820.42	20 321.04
Germany	82.522	43 468	121.62	92 651	95 854
Belarus	9.492	5 480	26.40	48 538	6 295
The Russian Federation	146.880	86 533.7	5.07	3 176 200	122 800
Kazakhstan	18.325	16 614	6.11	266 600	18 200

The effective management of the resource potential of Ukrainian rail transport enterprises becomes one of the most important tasks put forward by senior authorities in the context of enterprises strategic management, since it is the resource potential that determines the possibilities of enterprises to achieve one or another objective. The available resources, along with the reserves, form

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the resource potential of Ukrainian rail transport enterprises. However, the rail enterprises face the urgent issue of not just managing the resource potential, but managing the resource potential development as a complex dynamic system. The resource potential cannot be permanently static, it develops, transforms, modifies, exhausts and restores in the process of economic activity. A prerequisite for the improved management is evaluating the level of the resource potential development of rail enterprises in Ukraine.

2. Basic text

2.1. Literature review

The analysis of economic literature shows that publications on measuring the indices for evaluating the enterprises resource potential development are discrete, the set of instruments for such an evaluation depends on the individual author's vision, which is to consider the issues for the enterprises resource potential assessing without taking into account its development. It should be borne in mind that the resource potential is not static - it is dynamic. To measure the development level of enterprises resource potential, it is necessary to determine the types of resources that will be evaluated. The researches categorize resources of the enterprise differently, but usually the scientific literature points out four types of resources: material, labor, financial and informational ones.

Shamanska (2012) presents a general mathematical model for evaluating the enterprise resource potential with the definition of an integral index, as well as a system of indices for evaluating the resource potential. The advantage of the model offered by O. I. Shamanska is that it maximally covers all the components of the resource potential and calculates its integral index. However, the disadvantage of this model is the inaccuracy and subjectivity of expert estimates of the resource potential components values, their inconsistency with the objectives of the enterprise.

The approach offered by Kuzmenko (2014) is similar to the one by Shamanska. The author believes that the integral index of resource potential shall be calculated as the sum of complex indices for evaluating the production, labor, financial, and informational potentials, taking into account their importance in forming the resource potential of the enterprise. The advantage of Kuzmenko's model is that this approach is universal, allowing us to determine the types of different enterprises and correspondence of resource potential to strategic objectives and competitive requirements. The disadvantage of the model is the subjectivity of the integral index boundaries for its linguistic evaluation, which Kuzmenko emphasizes.

Khlebnikov (2011) believes that measuring the resource potential of an enterprise using only one index is impossible, it needs a system of indices which takes into account all functional components of the potential. The author divides all the resource potential of the enterprise into the material, production and personnel components, studying them in three directions: analyzing the components movement, their current status and efficiency of use. Thus, there are nine sets of indices in the author's model. The only general efficiency index of the resource potential use can be a multiplier of the effectiveness of potential use (the ratio between the market and book value of the enterprise). The advantage of this model is the availability of a clear system of indices, while the disadvantage is lack of a single generalized index indicating the state of the resource potential as a whole.

Danilova (2011) presents the method of calculating the integral index of resource potential efficiency, which consists of three stages. These stages include the calculation of each of the four components of the resource potential, the definition of the integral index as the average geometric one and the efficiency weighted average.

Shashina (2014) offers an advanced method for evaluating the confectionery industry resource potential, determining financial, production, marketing and investment potentials as parts of its resource potential. The integral index of the resource potential is then calculated as the geometric mean of complex indices of each direction potential.

Pilko and Malymina (2012) define the category of "the enterprise resource potential" and present a conceptual model of the enterprise resource provision, including managerial functions such as analysis, control, monitoring, forecasting activity and planning, motivation. Mitsenko and Kuchmenko (2010) consider the concept of the essence, structure and strategy of using the enterprise resource potential. At the same time, the authors note the need to evaluate the available resource potential and the level of its application.

Salun (2014) presents a model of deterministic factor analysis of the enterprise resource potential, and provides the economic-mathematical model of its value, which includes labor resources monetary evaluation, average annual cost of fixed assets, average annual cost of working capital of the enterprise and average annual cost of intangible assets of the enterprise.

Chorna (2015) offers a set of methods for evaluating the resource potential realization, as well as a system of indices for evaluating the commercial enterprises resource potential, which consists of complex and unitary, static and dynamic, general and partial indices. The author also singles out the following methodological approaches to evaluate the commercial enterprise resource potential: cost, functional, target, synergistic, benchmarking ones.

Schultz (1992) offers two models of management based on resources. At the same time, it is indicated that testing each model needs the use different projects. The author also gives a research program for each of the offered models. Helfat and Peteraf (2003) consider the concept of opportunities lifecycle for developing the theory of dynamic resources with the analysis of the stages of formation, development and maturity of the company, which allows to identify their sources of heterogeneities.

The analysis of the aforementioned economics literature made it possible to reveal that one of the disadvantages of calculating the integral index of resource potential evaluation is the subjectivity of the procedure of determining the significance of certain components in the overall structure of the subject or phenomenon. One of the ways to mitigate this disadvantage is the hierarchy analysis method (HAM), developed by the American mathematician T. Saati in the late 1970s. It lies in decomposing the problem into more simple parts and presenting it as a hierarchy, the elements of which are compared in parities according to a nine-point scale (Saati, 1993).

2.2. Methods of research

The objective of the research is to develop a methodological approach to evaluate the level of development of the resource potential of the rail transport enterprises of the country, which includes modeling the integral index for a decisive evaluation of this level.

Unlike the existing approaches, the authors of this article offer a methodology that includes determining the validity of the resource potential components using the hierarchy analysis method which is presented in the Figure 1. The method proposed by the authors is a sensitive mathematical apparatus for evaluating the level of resource potential development, which is vulnerable to even a minor deviations of the initial parameters that are difficult to consider in the managerial process.

Let us consider the proposed proprietary methodology in details. At the first stage, the task is set to evaluate the level of development of the resource potential of Ukrainian rail transport enterprises. The management decides about the objective of the task to evaluate the development of the rail transport resource potential, about managerial decisions to be made on the basis of this evaluation. A working group of experts is set up to carry out this procedure. The experts can be either employees of the enterprise or external independent experts.

The second stage provides the formation of a system of partial indices k_{ij} (i = 1, n; j = 1,4), which will most likely characterize the level of development the rail transport enterprises resource

potential by the four main groups of resources, namely: material, personnel, financial and informational, as well as their calculation. At the same time, a group of indices is determined separately, the high value of which stimulates the development of resource potential, and a group of indices the high value of which hampers the development of resource potential. The Table 2 shows the grouping of partial indices system to evaluate the enterprise resource potential.

The third stage valuates the partial indices, that is, brings them to one range (from 0 to 1) in order to compare them. The valuation procedure is carried out according to the formulas (5) (for indices stimulating the development), (6) (for indices hampering the development).

$$k_{ij}^{stym} = \frac{k_{ij} - k_{ijmin}}{k_{ijmax} - k_{ijmin}} \quad (5)$$

Where k_{ij}^{stym} – partial index i of the indices group j, which stimulates the resource potential development;

k_{ij} – partial index i of the indices group j;

$k_{ij\ max}$ – maximum value among the indices which stimulate the development, in the indices group j;

$k_{ij\ min}$ – minimum value among the indices which stimulate the development, in the indices group j.

$$k_{ij}^{galm} = 1 - \frac{k_{ij} - k_{ijmin}}{k_{ij\,max} - k_{ij\,min}} \quad (6)$$

Where k_{ij}^{galm} – partial index i of the indices group j, which hampers the resource potential development;

k_{ij} – partial index i of the indices group j;

$k_{ij\ min}$ – the minimum value among the indices hampering the development, in the indices group j;

$k_{ij\ max}$ – the maximum value among the indices hampering the development, in the indices group j.

At the fourth stage, the method of paired comparisons (T. Saati's method) helps to evaluate the importance (relative importance) of each partial index in its group. Four special groups of experts in the railway material and technical, its staff, financial situation and in information and management resources, evaluate the partial indices for each group using the method of paired comparisons.

Source: Proprietary technology.

Stage I. Setting the task to evaluate the level of development of rail transport resource potential

Stage II. Forming a system of partial indices for evaluating resource potential development level k_{ij} ($i = \overline{1,n}$; $j = \overline{1,4}$) according to four groups of indices: material, labor, financial and informational

Stage III. Valuating the obtained values of partial indices for evaluating resource potential development level

$$k_{ij}^{stym} = \frac{k_{ij} - k_{ijmin}}{k_{ijmax} - k_{ijmin}}$$ – for the indices stimulating the development

$$k_{ij}^{galm} = 1 - \frac{k_{ij} - k_{ijmin}}{k_{ij\,max} - k_{ij\,min}}$$ – for the indices hampering the development

Stage IV. Determining the proportion of the partial indices for evaluating resource potential development level (p_{ij}) and calculating the level of experts opinions consistency (W)

Stage V. Calculating integral group indices of the resource potential development level according to four basic components: material, labor, financial and informational ones

$$K_j = \sum_{i=1}^{n} k_{ij} * p_{ij}$$

Stage VI. Evaluating priority of the components of the resource potential development level in accordance with the objectives of the rail transport development using hierarchy analysis method with determining the components proportion ($\omega_m, \omega_t, \omega_f, \omega_i$)

Stage VII. Calculating complex integral index for evaluating the development level of the rail transport resource potential:

$$K_{overall.lev.RP.dev.} = \sqrt[4]{K_m * \omega_m * K_t * \omega_t * K_f * \omega_f * K_i * \omega_i}$$

Stage VIII. Interpreting the obtained value of the rail transport resource potential development level using Harrington scale

Fig. 1: Methodology to Evaluate the Development Level of the Resource Potential of the Rail Transport Enterprises of A Country.

Table 2: Partial Indices System to Evaluate the Development Level of the Resource Potential of the Rail Transport Enterprises

Index	Stimulates or hampers the development	Characteristics	Calculating formula	Conventional signs
1 group – Material				
1) The rolling stock renewal ratio	Stimulates	Characterizes the share of the cost of new units of the rolling stock (with operating life not more than 5 years) in the total cost of the railway rolling stock	$K_{1.1} = \frac{F_n}{F_z}$	F_n– the cost of the new units of the rolling stock within the railway fixed assets; F_z– total cost of the railway rolling stock.
2) The transport infrastructure wear ratio	Hampers	Characterizes the share of the cost of the railway transport infrastructure in the total cost that has exhausted its resource and needs to be updated.	$K_{1.2} = \frac{V_{zn.tr.inf.}}{V_{infr.tr.zag.}}$	$V_{zn.tr.inf.}$– the cost of the worn transport infrastructure; $V_{infr.tr.zag.}$ – total cost of the railway transport infrastructure
3) The logistics infrastructure wear ratio	Hampers	Characterizes the share of the cost of the railway logistics infrastructure in the total cost that has exhausted its resource and needs to be updated.	$K_{1.3} = \frac{V_{zn.log.infr.}}{V_{log.infr.zag.}}$	$V_{zn.log.infr.}$– the cost of the worn logistics infrastructure; $V_{log.infr.zag.}$– total cost of the logistics infrastructure
4) Return on assets	Stimulates	Index showing the number of transportation services provided (UAH) for each hryvnia invested in fixed assets. The ratio of revenue (revenue) to the average annual cost of fixed assets	$K_{1.4} = \frac{D}{\overline{OZ}}$	D – the total amount of revenue from transporting; $\overline{OZ}$– the average annual cost of fixed assets.
5) Fuel availability ratio	Stimulates	The ratio of fuel stocks at the beginning of the reporting period to the needs (fuel consumption) for the reporting period	$K_{1.5} = \frac{Z_p}{V_p}$	Z_p – the fuel stocks at the beginning of the reporting period; V_p – fuel consumption for the reporting period.
6) Fuel and electricity consumption in cargo traffic ratio	Hampers	Fuel and electric power consumption for transportation of 1 t of cargo per 1 km of road	$K_{1.6} = \frac{V_p}{V_o}$	V_p – fuel and electric power consumption (UAH) for the reporting period; V_o – cargo turnover (t-km) for the reporting period.
7) Fuel and electricity consumption in passenger traffic ratio	Hampers	Fuel and electric power consumption for transportation of 1 passenger per 1 km of road	$K_{1.7} = \frac{V_p}{P_o}$	V_p – fuel and electric power consumption (UAH) for the reporting period; P_o – passenger turnover for the reporting period, passenger – km.

Table 2:

1) Railway carrying capacity ratio	Stimulates	The average number of trains, going through 1 km of railways per day	$K_{1.8} = \frac{K_p}{L}$	K_p– the number of trains moving during 24 hours; L – total run of railway track.
2) Stocks turnover ratio	Stimulates	The number of the stock of material replacement for the reporting period showing how many times the stock of material is updated for a specified period	$K_{1.9} = \frac{R_m}{\overline{Z_m}}$	R_m – material consumption for the reporting period; $\overline{Z_m}$ – the average balance of materials for the reporting period.
2 group – Labor				
1) Staff security ratio	Stimulates	The ratio of the number of employees to the number of salaries	$K_{2.1} = \frac{N_{pr}}{N_o}$	$N_{пр}$ – the number of employees; N_o – the number of salaries.
2) Labor productivity (output, labor intensity)	Stimulates	Characterizes the volume of tariff transportations (both passenger and cargo), which falls on one working employee	$K_{2.2} = \frac{(\sum p^g l + 2\sum p^p l)}{\overline{N_{per}}}$	$p^g l$ – tariff cargo turnover, t-km; $p^p l$ – passenger turnover, passengers-km; $\overline{N_{per}}$ – the average number of employees engaged into transportation.
3) Labor turnover ratio	Hampers	The coefficient of labor turnover is the ratio of the number of employees discharged from the organization during a certain period (net of inevitably discharged) to the average number of employees for the relevant period	$K_{2.3} = \frac{(N_z - N_{n.z.})}{\overline{N_{per}}}$	N_z – the number of discharged employees; $N_{n.z.}$– the number of inevitably discharged employees; $\overline{N_{per}}$ – the average number of employees engaged into transportation.

4)	Admission turnover ratio	Stimulates	The ratio of admitted employees to the average number of staff	$K_{2.4} = \frac{N_p}{\overline{N}} * 100\%$	N_p – the number of admitted employees ; $\overline{N}$ – the average number of the staff.
5)	Discharge turnover ratio	Hampers	The ratio of discharged workers to the average number of staff	$K_{2.5} = \frac{N_z}{\overline{N}} * 100\%$	N_z– the number of discharged employees; $\overline{N}$ – the average number of the staff.

Table 2:

1)	Labor turnover ratio	Hampers	The coefficient of labor turnover is the ratio of the number of employees discharged from the organization during a certain period (net of inevitably discharged) to the average number of employees for the relevant period	$K_{2.3} = \frac{(N_z - N_{n.z.})}{\overline{N_{per}}}$	N_z – the number of discharged employees; $N_{n.z.}$– the number of inevitably discharged employees; $\overline{N_{per}}$ – the average number of employees engaged into transportation.
2)	Admission turnover ratio	Stimulates	The ratio of admitted employees to the average number of staff	$K_{2.4} = \frac{N_p}{\overline{N}} * 100\%$	N_p– the number of admitted employees to the average number of staff; $\overline{N}$– the average number of staff.
3)	Discharge turnover ratio	Hampers	The ratio of discharged workers to the average number of staff	$K_{2.5} = \frac{N_z}{\overline{N}} * 100\%$	N_z – the number of discharged employees to average number of staff; $\overline{N}$– the average number of staff.
4)	Personnel qualification level	Stimulates	The ratio of the number of employees who, according to their qualifications, correspond to their position, rank to the average number of staff	$K_{2.6} = \frac{N_{kv}}{\overline{N}}$	N_{kv} – the number of employees who, according to their qualifications, correspond to their position; $\overline{N}$– the average number of staff.
5)	Personnel stability ratio	Stimulates	The ratio of the number of employees with work experience of more than 1 year to their average number	$K_{2.7} = \frac{N_s}{\overline{N}}$	N_s – the number of staff with work experience (up to 1 year); $\overline{N}$– the average number of staff.
6)	Level of satisfaction with the relationships in the team	Stimulates	The ratio of the number of employees who like the existing relationships in the team to the total number of employees of the enterprise	$K_{2.8} = \frac{N_{PV}}{N_{zag}}$	N_{PV} – the number of employees who like the existing relationships in the team; N_{zag} – the total number of employees.

Table 2:

1)	Level of satisfaction with the relationship with the management	Stimulates	The ratio of the number of employees satisfied with the existing relationship with the management to the total number of employees	$K_{2.9} = \frac{N_{PVK}}{N_{zag}}$	N_{PVK} – the number of employees satisfied with the existing relationship with the management; N_{zag} – the total number of employees.
2)	Disease rate at the enterprise	Hampers	The ratio of disability man-days due to the diseases to the total number of man-days	$K_{2.10} = \frac{LD_{nepr.}}{LD_{zag.}}$	$LD_{nepr.}$– disability man-days due to the diseases, man-days; $LD_{zag.}$– general man-days.
3 group – Financial					
1)	Current liquidity ratio	Stimulates	Indicates to what extent current assets are sufficient to meet the present liabilities	$K_{3.1} = \frac{OA+VMP}{PZ}$	OA – working assets, VMP – future expenses; PZ– current liabilities.
2)	Intermediate liquidity ratio	Stimulates	Indicates the extent to which current assets, net of slow-moving assets, cover current liabilities	$K_{3.2} = \frac{(OA-Z-VMP)}{PZ}$	OA – working assets, Z – stocks; PZ – current liabilities; VMP – future expenses.
3)	Absolute liquidity ratio	Stimulates	Shows which part of short-term liabilities can be repaid immediately, the most stringent liquidity criterion	$K_{3.3} = \frac{GK+PFI}{PZ}$	GK– monetary funds and the equivalents in national and foreign currencies, current financial investments; PFI– current financial investments; PZ– current liabilities.
4)	Solvency ratio (autonomy)	Stimulates	Characterizes the share of the enterprise equity capital in the total amount advanced in its activities	$K_{3.4} = \frac{VK}{B}$	VK – owner's equity; B – balance (total cost of attracted funds sources).
5)	Financial risk ratio (financial leverage)	Hampers	Shows the ratio of external funds and owner's equity	$K_{3.5} = \frac{B - VK}{VK}$	VK – owner's equity; B – balance (total cost of attracted funds sources).
6)	Working capital financed by equity to total assets ratio	Stimulates	Ratio of own working capital to working assets	$K_{3.6} = \frac{OA - PZ}{OA}$	OA – working assets; PZ – current liabilities.
7)	Current assets to equity ratio	Stimulates	Indicates which part of its working capital is in circulation, that is, allowing its free maneuvring	$K_{3.7} = \frac{VK - NA}{VK}$	VK– owner's equity; NA – fixed assets;

Table 2:

1)	Asset turnover ratio	Stimulates	Calculated as the ratio of net revenues to the average value of the enterprise balance	$K_{3.8} = \frac{CHV}{\overline{B}}$	CHV – net revenues from products sales; $\overline{B}$ – the average value of the enterprise

					balance.
2)	Turnover rate of payables	Stimulates	Shows the accounts payable circulation velocity	$K_{3.9} = \frac{CHV}{\overline{KZ}}$	CHV – net revenues from products sales; $\overline{KZ}$– annual average rate of accounts payable.
3)	Receivable turnover	Stimulates	Shows the enterprise receivables turnover circulation velocity	$K_{3.10} = \frac{CHV}{\overline{DZ}}$	CHV– net revenues from products sales; $\overline{DZ}$– annual average rate of receivables.
4)	Return on assets	Stimulates	The ratio of net profit to the average annual enterprise balance	$K_{3.11} = \frac{CHP}{\overline{B}}$	CHP – net revenues; $\overline{B}$ – average annual balance .
4 group – Informational					
1)	The R & D staff involvement and information technologies ratio	Stimulates	Characterizes the enterprise personnel involvement in scientific and technical developments. Percentage of personnel involved into R & D and information technology	$K_{4.1} = \frac{N_{NDDKR}}{N_{zag.}}$	N_{NDDKR}– the number of personnel involved into R & D; $N_{zag.}$– the total number of enterprise personnel for the reporting period.
2)	Technical support for information systems	Stimulates	The number of employees who use information systems in their work to the total number of employees	$K_{4.2} = \frac{N_{IS}}{N_{zag.}}$	N_{IS}– the number of personnel provided with information systems; $N_{zag.}$– the total number of enterprise personnel for the reporting period.
3)	R & D financing ratio	Stimulates	Characterizes the share of the enterprise budget to provide research and development	$K_{4.3} = \frac{V_{NDDKR}}{B_{zag}}$	V_{NDDKR}– the enterprise expenditures for R & D; B_{zag} – the total budget of the firm.
4)	Management efficiency ratio	Stimulates	The ratio of gross profit to the total cost of managerial labor (man-days)	$K_{4.4} = \frac{Pr}{V_{upr.praci}}$	Pr – gross profit; $V_{upr.praci}$ – the total expenditures for managerial labor (man-days).

Table 2:

1)	Patents profit margin	Stimulates	The ratio of gross profit to the number of the patents owned by the enterprise	$K_{4.5} = \frac{Pr}{KP}$	Pr – gross profit; KP – number of patents.
2)	Control ratio	Hampers	The ratio of the average actual control rate at the enterprise to the standard controllability norm	$K_{4.6} = \frac{NK_{sf}}{NK_n}$	NK_{sf} – the average actual control rate of the enterprise; NK_n – standard controllability norm.
3)	Operational efficiency ratio	Stimulates	Characterizes timeliness of documents execution in the executive office	$K_{4.7} = \frac{(\sum_{i=1}^{n} D_i * d_i * R_i)}{\sum D_i * R_i}$	D_i – the accepted deadline of certain documents execution; d_i – certain type documents proportion; R – lagging behind the accepted deadline for the execution of documents; n – the number of documents type.
4)	Share of intangible assets in the structure of non-current assets of the enterprise	Stimulates	Characterizes the proportion of intangible assets in the structure of non-current assets of the enterprise	$K_{4.8} = \frac{NA}{\overline{A_{neob.}}}$	NA – intangible assets; $\overline{A_{neob.}}$ – the average annual cost of intangible assets.

Each group will have ten respondents filling in the "matrix of judgments", which presents all the indices of the corresponding group. The indices proportion is calculated according to the formula (7) [7]:

$$a_{i,j} = \frac{\sqrt[n_i]{\prod_{Y=1}^{n_i} a_{XY}}}{\sum_{Y=1}^{n_j} \sqrt[n_i]{\prod_{Y=1}^{n_i} a_{XY}}} \quad (7)$$

Where $a_{i,j}$ – j-index proportion in the i-group;
a_{xy} – expert score of x-index relative to y-index;
n – The number of indices in i-group.
The final value of each index proportion is defined as the arithmetic mean of the corresponding ten values obtained from each expert. As a result, correction factors p_{ij} are obtained, allowing to perform the ranking of indices and calculate integral group indices of the development level of the enterprise resource potential.
The degree of consistency of expert opinions for each group is calculated via the concordance coefficient, which is calculated according to the formula (8) [11]:

$$W = \frac{12S}{m^2 * (n^3 - n)} \quad (8)$$

Where W – the concordance coefficient;
n – The number of final indices per each group;
m – The number of respondents (m=10);
S – The sum of squares of differences.
The sum of squares of differences (S) is calculated according to the formula (9) [8]:

$$S = \sum_{i=1}^{n} (\sum_{j=1}^{m} x_{ij} - \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} x_{ij}}{n})^2 \quad (9)$$

Where S – the sum of squares of differences;
x_{ij} – expert score of the i-index by the expert j.
The fifth stage provides the calculation of integral group indices for evaluating the development level of resource potential (K_M, K_T, K_F, K_I) as the sum of products of the partial indices k_{ij} by the corresponding correction factors p_{ij} in the corresponding group of indices.
Ehe sixth stage evaluates the significance of the components of the resource potential development level by the hierarchy analysis method with further specification of the proportion of the material, labor, financial and informational components of the resource potential ($\omega_m, \omega_t, \omega_f, \omega_i$). Let us suppose that there is a task to efficiently allocate the budget funds to develop the resource potential of the rail transport enterprise in accordance with the main objectives of this enterprise development. There are the following main areas of financing of resource potential according to the following main components of the resource potential: material resources, labor resources, financial resources and informational

resources. Each of these types of resources has different effects on achieving each specific development goal. Among the main objectives of rail transport enterprises development, we distinguish the following: security, service quality, reduces cost, ecology and infrastructure development. This task can be represented as a hierarchical structure in the Figure 2.
Source: Proprietary technology.

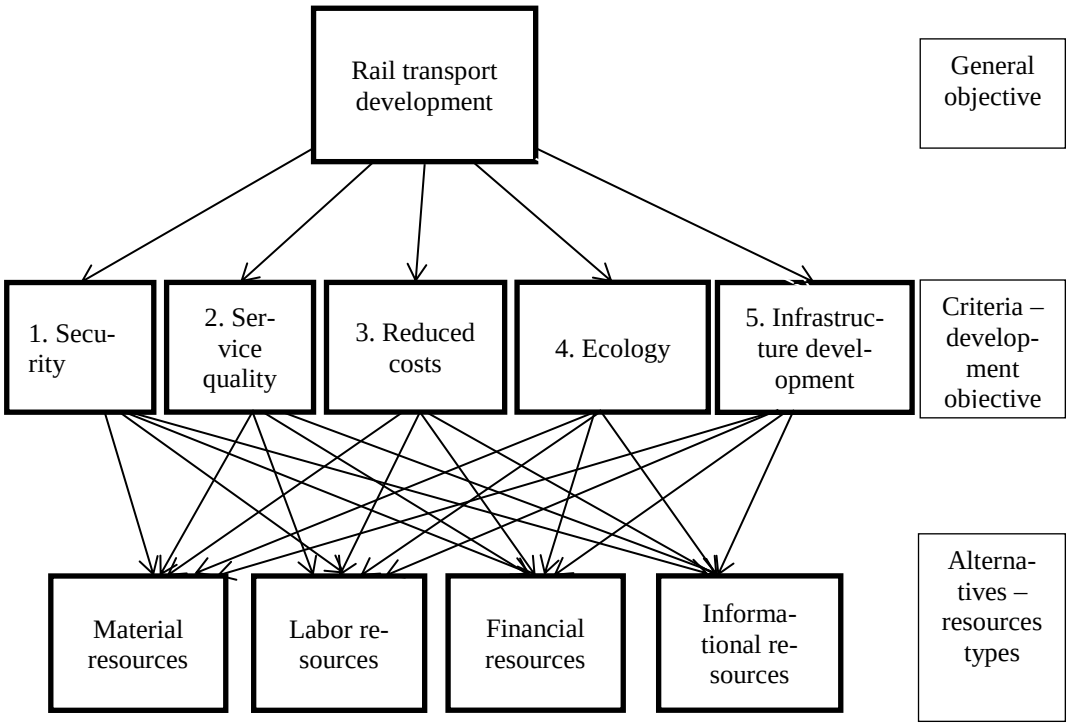


Fig. 2: Hierarchical Structure of the Hierarchy Analysis Method Task.

As the Figure 2 shows, the first level of the hierarchy has the main objective - the rail transport development, the second level shows the criteria - the rail transport development objectives, the third level – the alternatives - four components of the resource potential: material, financial, labor and informational resources. Thus, the task of the hierarchy analysis method is to find the optimal ratio of the resource potential components in accordance with Ukrainian rail transport development objectives.
The seventh stage calculates a complex integrated index for evaluating the development level of the resource potential Ukrainian rail transport enterprises as the average compound of the products of integral group indices and their proportions according to the formula (10):

$$K_{overall.lev.RP.dev.} = \sqrt[4]{K_m * \omega_m * K_t * \omega_t * K_f * \omega_f * K_i * \omega_i} \quad (10)$$

Where $K_{overall.lev.RP.dev.}$ – general level of the resource potential development ratio;
K_m – the group index of the material potential evaluation;
K_t – the group index of the labor potential evaluation;
K_f – the group index of the financial potential evaluation;
K_i – the group index of the informational potential evaluation;
$\omega_м$ – proportion of the resource potential material component;
ω_t – proportion of the resource potential labor component;
ω_f – proportion of the resource potential financial component;
ω_i – proportion of the resource potential informational component.
The eighth stage analyzes the obtained value of the complex integral index of the res3ource potential development. For this purpose, the universal Harrington verbal-numerical scale is used, which is given in the Table 3 [9]. This scale establishes the correlation between physical (numeric) and psychophysical parameters (high/low, good/bad, large/small).

Table 3: Harrington Verbal-Numerical Scale [9]

No.	Resource potential development management level	Numeric value
1.	Very high	0,8 – 1,0
2.	High	0,63 – 0,8
3.	Medium	0,37 – 0,63
4.	Low	0,2 – 0,37
5.	Very low	0 – 0.2

Thus, the enterprise management using the Harrington scale has the opportunity to interpret the obtained value of the complex integrated index of resource potential development and to make managerial decisions based on it.

3. The results

For the enterprises under investigation, to try and test the offered methodology, we selected the "Southern Railways" Regional Branch of PJSC «Ukrzaliznytsya» (hereinafter the «Southern Railway») and «Motor-car depot Lyubotin» production unit of the "Southern Railways" Regional Branch of PJSC «Ukrzaliznytsya" (hereinafter ME «Motor-car depot Lyubotin»). This was done in order to prove that the proprietary technology can be applied for both large rail enterprises and for their separate subdivisions. The calculations involved the data of economic accounting of these enterprises for 2015-2017.
The results of the partial indices calculation for evaluating the development level of the resource potential for these enterprises are presented respectively in the Tables 6 and 7. Then follows the calculation of the partial indices proportion for evaluating the development level of the resource potential (p_{ij}) and of the expert opinions consistency level (W) for each group. After that, the integral group indices are calculated following the main components of the resource potential (Tables 4, 5).
Next, the authors evaluate the priorities of the components of the development level of resource potential via the hierarchy analysis method. The calculation results are shown in the Figure 3.
As the Figure 3 shows, the hierarchy analysis method demonstrated the following priorities values of the resource potential components: material - 0.245, labor - 0.241, financial - 0.174, informational - 0.340.
The last stage calculates the complex integral index of evaluating the development level of the resource potential of the rail transport

enterprise. The calculation resulted into the data (the development level of the resource potential according to the Harrington verbal-numerical scale for ME "Motor-car depot Lyubotin" is equal to 0.152; for the "Southern Railways" - 0.09), which testify to the very low development level of the resource potential of these enterprises. Based on the data obtained, the management of both enterprises can make appropriate managerial decisions.

Table 4: The Results of Calculating the Integral Indices According to the Main Components of the Resource Potential for the ME «Motor-Car Depot Lyubotin»

Year	2015	2016	2017
Material potential	0.463	0.439	0.506
Labor potential	0.688	0.625	0.598
Financial potential	0.77	0.724	0.701
Informational potential	0.795	0.795	0.795
The integral index of resource potential development level	0.09	0.1	0.12

Table 5: The Results of Calculating the Integral Indices According to the Main Components of the Resource Potential for the "Southern Railways"

Year	2015	2016	2017
Material potential	0.545	0.549	0.514
Labor potential	0.781	0.821	0.852
Financial potential	0.067	0.083	0.165
Informational potential	0.795	0.795	0.795
The integral index of resource potential development level	0.09	0.1	0.2

Source: Proprietary technology.

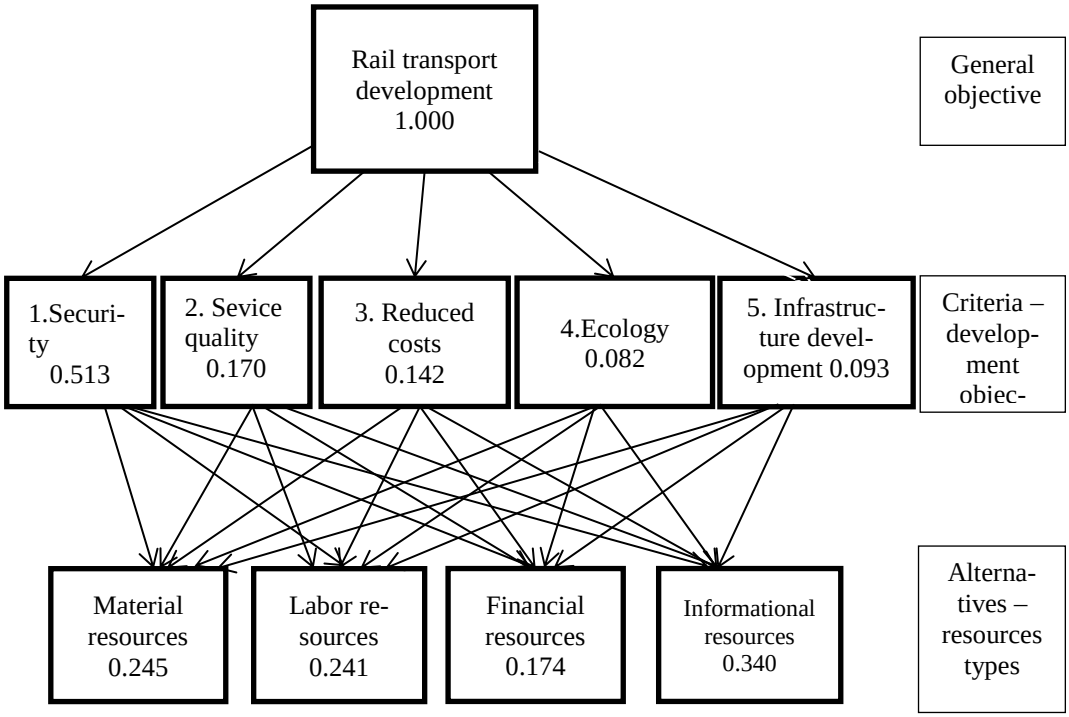


Fig. 3: The Results of the Calculation of the Proportion of the Criteria and Alternatives via the Hierarchy Analysis Method.

Table 6: The Results of Calculating and Rating the Partial Indices of Evaluating the Resource Potential Development Level for the ME «Lyubotin Motor-Car Depot» For 2015-2017

Indices	2015	2016	2017	Index type	Rated value 2015	Rated value 2016	Rated value 2017
Material							
1. The rolling stock renewal ratio	0.3	0.2	0.25	stimulates	0.125	0.080	0.109
2. The transport infrastructure wear ratio	0.2	0.15	0.103	hampers	1.000	1.000	1.000
3. The logistics infrastructure wear ratio	0.06	0.056	0.044	hampers	1.000	1.000	1.000
4. Return on assets	2.06	0.956	0.069	stimulates	0.050	0.030	0.010
5. Fuel availability ratio	0.08	0.06	0.051	stimulates	0.000	0.000	0.000
6. Fuel and electricity consumption in cargo traffic ratio	3375	5532	7242.7	hampers	0.000	0.000	0.000
7. Fuel and electricity consumption in passenger traffic ratio	0.2	0.107	0.105	hampers	1.000	1.000	1.000
8. Railway carrying capacity ratio	0.5	0.3	0.246	stimulates	0.521	0.350	0.107
9. Stocks turnover ratio	2.2	2.002	1.875	stimulates	1.000	1.000	1.000
Labor							
1. Labor turnover ratio	0.06	0.09	0.15	hampers	0.050	0.032	0.028
2. Admission turnover ratio	0.06	0.09	0.16	stimulates	0.000	0.000	0.000
3. Discharge turnover ratio	0.06	0.09	0.15	hampers	0.050	0.032	0.028
4. Personnel stability ratio	0.97	0.94	0.84	stimulates	1.000	0.899	0.807
5 Staff security ratio	0.9921	0.9960	0.9981	stimulates	1.000	1.000	1.000
6. Labor productivity (output, labor intensity)	0.75	0.5	0.37	stimulates	0.380	0.302	0.246
7. Personnel qualification level	0.94	0.95	0.92	stimulates	0.970	0.916	0.908
8. Level of satisfaction with the relationships in the team	0.79	0.74	0.82	stimulates	0.870	0.782	0.784
9. Level of satisfaction with the relationship with the management	0.78	0.72	0.74	stimulates	0.890	0.705	0.695
10. Disease rate at the enterprise.	0.05	0.05	0.05	hampers	1.000	1.000	1.000

Table 6:

3. Financial							
1. Current liquidity ratio	0.25	0.5	0.019	stimu-lates	0.05	0.01	0.01
2. Intermediate liquidity ratio	0.004	0.01	0.002	stimu-lates	0.05	0.01	0.01
3. Absolute liquidity ratio	0	0.05	0	stimu-lates	0.05	0.01	0.01
4. Solvency ratio	0.334	0.35	0.273	stimu-lates	0.25	0.01	0.01
5. Financial risk ratio (financial leverage)	1.2	2	2.66	hampers	0.00 *	0.00 *	0.00 *
6. Working capital financed by equity to total assets ratio	-0.42	-0.52	-0.98	stimu-lates	0.00	0.00	0.00
7. Current assets to equity ratio	1.2	1.4	1.64	stimu-lates	0.10	0.05	0.01
8. Asset turnover ratio	0.4	0.333	0.233	stimu-lates	0.03	0.01	0.01
9. Turnover rate of payables	0.4	0.32	0.209	stimu-lates	0.50	0.20	0.01
10. Receivable turnover	102	153	182.74	stimu-lates	1.00	1.00	1.00
11. Return on assets	-0.02	-0.02	-0.067	stimu-lates	0.03	0.01	0.00
4. Informational							
1. The R & D staff involvement and information technologies ratio	0.033	0.030	0.025	stimu-lates	1.00	1.00	1.00
2. Technical support for information systems	0.200	0.100	0.062	stimu-lates	1.00	1.00	1.00
3. R & D financing ratio	0.002	0.001	0.001	stimu-lates	1.00	1.00	1.00
4. Management efficiency ratio	-12.000	-11.000	-10.820	stimu-lates	1.00	1.00	1.00
5. Management efficiency ratio	-10120.0	-12350.0	-37493.8	stimu-lates	0.00	0.00	0.00
6. Control ratio	1.250	1.250	1.250	hampers	0.00 *	0.00 *	0.00 *
7. Operational efficiency ratio	0.500	0.400	0.370	stimu-lates	1.00	1.00	1.00
8. Share of intangible assets in the structure of non-current assets of the enterprise	0.350	0.300	0.240	stimu-lates	1.00	1.00	1.00

* - as a hampering index is the only one in its group, we accept its value equal to 0

Table 7: The Results of Calculating and Rating the Partial Indices of Evaluating the Resource Potential Development Level for the "Southern Railways" for 2015-2017

Index	2015	2016	2017	Index type	Rated value 2015	Rated value 2016	Rated value 2017
1	2	3	4	5	6	7	8
1. Material							
1. The rolling stock renewal ratio	0.025	0.02	0.02	stimulates	0.00	0.00	0.00
2. The transport infrastructure wear ratio	0.08	0.1	0.12	hampers	1.00	1.00	1.00
3. The logistics infrastructure wear ratio	0.03	0.05	0.05	hampers	1.00	1.00	1.00
4. Return on assets	13	12	11.39	stimulates	1.00	1.00	1.00
5. Fuel availability ratio	0.1	0.07	0.05	stimulates	0.02	0.01	0.00
6. Fuel and electricity consumption in cargo traffic ratio	82	78	86.20	hampers	0.79	0.85	0.82
7. Fuel and electricity consumption in passenger traffic ratio	320	350	467.51	hampers	0.00	0.00	0.00
8. Railway carrying capacity ratio	0.12	0.09	0.07	stimulates	0.02	0.01	0.00
9. Stocks turnover ratio	12	10	5.00	stimulates	0.63	0.41	0.44
2. Labor							
1. Labor turnover ratio	0.04	0.07	0.012	hampers	1.00	1.00	1.00
2. Admission turnover ratio	0.07	0.05	0.015	stimulates	0.00	0.00	0.00
3. Discharge turnover ratio	0.015	0.015	0.015	hampers	0.22	0.51	0.95
4. Personnel stability ratio	0.95	0.9	0.796	stimulates	0.95	0.90	0.80
5 Staff security ratio	1	1	0.99	stimulates	1.00	1.00	1.00
6. Labor productivity (output, labor intensity)	0.85	0.75	0.68	stimulates	0.90	0.80	0.68
7. Personnel qualification level	0.99	0.97	0.97	stimulates	0.99	0.99	0.98
8. Level of satisfaction with the relationships in the team	0.81	0.79	0.75	stimulates	0.90	0.85	0.75
9. Level of satisfaction with the relationship with the management	0.74	0.7	0.68	stimulates	0.85	0.75	0.68
10. Disease rate at the enterprise.	0.15	0.12	0.07	hampers	0.00	0.00	0.00

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3. Financial							
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8. Share of intangible assets in the structure of non-current assets of the enterprise	0.350	0.300	0.240	stimu-lates	1.00	1.00	1.00

*- as a hampering index is the only one in its group, we accept its value equal to 0.

4. Conclusions

Thus, the application of the approach offered by the authors will enable the top management to more accurately plan the use of the rail enterprises resources and to be confident in correspondence of the resource potential to the strategic aims of the enterprise.

This scientific article presents the proprietary technology for evaluating the development level of the resource potential of rail transport enterprises, which allows to obtain a more adequate assessment of the development level of the resource potential of the enterprise owing to the hierarchy analysis method to determine the proportion of each type of resource, and the Harrington scale to interpret the value of the evaluation integrated index. The advantage of this research is that its results have been tried and tested in the economic activities of operating enterprises.

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