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Modelling the Process of Assessing the Corruption Orientation of Regulatory Legal Acts

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Abstract. In the conditions of growing requirements for methods and means of combating negative phenomena of society, prevention and deterrence of corrupt actions of officials by creating new and editing old normative legal acts can significantly limit the development of such offenses and have a positive effect on the economic state of the country. The urgent task is to develop simple and effective methods of modelling and assessing the level of corruption orientation of normative legal acts. The paper examines the problem of quantitative assessment of the negative phenomenon of corrupt activity of officials, which can be stimulated by regulatory and legal acts. The purpose of the article was to improve the methods and techniques of analysis of the process of assessing the quality of normative legal acts by modelling their corruption orientation. The methods of fuzzy set theory and fuzzy logical inference, as well as the methods of probability theory are used in the process of modelling the quantitative assessment of the level of corruption oriented legal acts. The proposed approach makes it possible to simultaneously take into account separate criteria that are based on subjective assessments and have uncertainties of various natures, and are also characterized by a large number of them with their inequality and antagonism. At the same time, the modelling process provides the possibility of using both a clear and unclear representation of the initial data, reduces the influence of subjectivity of expert evaluation factors of a heuristic nature. There is no need to determine the weight of each individual factor when forming a global criterion for deciding on the level of corruption orientation of a normative legal act. On the basis of the obtained values of the global criterion, a decision is made to choose one or another variant of the normative legal act. The paper examines the stages of implementation of the proposed approach to assessing the level of corruption orientation of the normative legal act on the reclamation of forestry lands disturbed as a result of amber mining. The results of the work can be useful in the development of drafts of new legislation, as well as for researchers of methods of control and management of complex technical and economic systems

Keywords: fuzzy set, membership function, linguistic variable, quality indicator, random variable, membership probability

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INTRODUCTION

In a state where there is no sufficient control over corrupt activities, any agreement between private and public sector entities, by means of which public assets are illegally transformed into private ones, can occur. This corruption is often used as a synonym for a high level of legislative corruption. The performance of the authority's actions is based on legislative and regulatory legal acts (RLA), which establish powers and restrictions on the work of officials. Some actions may have a corruption component (corruption risk). Identifying factors that influence the existence or increase of the corruption risk is a very difficult and urgent task. Even an approximate solution to such a task will provide an opportunity to change the RLA for the better and prevent corruption offenses. Article 15 of the Law of Ukraine "On Principles of Preventing and Combating Corruption" [1] establishes the obligation to carry out anti-corruption expertise of draft regulatory legal acts. The use of a scientific approach to the formalization of the process of such an examination helps to increase its efficiency and objectivity. The works [2-4] are devoted to the problem of assessing the state of complex technical, economic, and organizational systems. Quantitative evaluation of the

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corruption orientation of the legislation occupies a separate niche, which previously received little attention among the many studies. To eliminate the negative impact on society, the main anti-corruption programs are adopted in Article 19 of the Law of Ukraine "On Prevention of Corruption" [1]. A partial implementation of this law is the methodology for managing corruption risks in the activities of government bodies [2], which forms the methodology for assessing the quality of RLAs, and also notes the following: classification of corruption risks by categories and types; stages of assessment of RLA corruption risks. Quantitative assessments in [2] take into account only precisely defined discrete data, which does not make it possible to make a continuous assessment of corruption risks, which are of a vague nature.

In the works [3-4] authors examine the issue of assessing the reliability of the functioning of complex technical systems under the conditions of extreme impacts and a shortage of resources for their restoration. At the same time, methods of forecasting indicators of survivability of the executive element of the special purpose system are being developed on the basis of analytical-stochastic modelling of the conflict situation. The indicator of the quality of system functioning is the mathematical expectation of the number of executive elements of the special purpose system that have retained their ability to perform tasks effectively. According to the results of the study, obtaining results is based on statistical and grapho-analytical modelling of processes, which can take into account the importance of various parameters only by introducing their weighting factors of influence on the state of the system. At the same time, the value of these coefficients can change very significantly over time. This can lead to systematic erroneous results in decision-making. Works [5-6] are devoted to the solution of an actual scientific and technical problem – the development of models and methods of forming project portfolios based on the method of their actualization, identification and selection of projects based on the evaluation and prioritization of portfolios. To determine priority projects, a method has been developed, which is based on the definition of a generalized priority criterion for each project, the coefficient of its budget burden and the formation of a ranking table. The basis of the table formation process is statistical data, which may not always exist in sufficient volume, and sometimes they are absent. Otherwise, the ranking process is based on the judgment of experts, which has a very high level of uncertainty, which is not taken into account when making a decision. In work [7], the issue of evaluating the corruption orientation of RLA is considered, taking into account the unclear nature of the factors, but a significant drawback is that the result of the calculation can only be clear data. In [8-10], the task of vague assessment of the state of technical and economic systems is solved, while the possibility of taking legal concepts into account as a component of the assessment is not analysed.

Thus, it is problematic to evaluate the corruption of a regulatory legal act by the usual numerous methods, since the components of the evaluation system have different physical dimensions, and many of them are defined only at the conceptual level. Thus, the authors consider it expedient to propose to evaluate the corruption of the RLA using the apparatus of fuzzy set theory and fuzzy logical conclusion. The essence of the mentioned approach is that, having conducted a numerical evaluation of the conceptual components from the positions of fuzzy logic, correctly bring them to the same proportionality, and then, based on a fuzzy logical conclusion, obtain a systematized conclusion about the effectiveness of the RLA norms. The main goal of this study is to improve the methods and methods of analysis of the process of assessing the quality of normative legal acts by modelling their corruption orientation. The object of the research is the process of assessing the corruption orientation of normative legal acts. The subject of the study is the methods of fuzzy analysis and decision-making in conditions of data uncertainty.

MATERIALS AND METHODS

The following scientific methods were used in the study: methods of the theory of fuzzy sets and fuzzy logical inference, as well as methods of the theory of probabilities. Assessment of whether fuzzy values of a parameter (indicator) belong to its possible fuzzy states. The state of the parameter can be represented as a linguistic variable that has multiple values, from negative to positive. In the process of analysing a parameter, its membership in the i-th fuzzy set should be determined using the membership function $\mu_i(x_0)$, where i is the number of the set by which this function is defined. It exists on the entire set of values of the parameter or linguistic variable, x_0 is the numerical value of the parameter. It is worth noting that the number x_0 can simultaneously belong to one or several states with different degrees of belonging. It should be noted that the general membership of the fuzzy parameter x cannot be less than 1 for any value of x on the set X:

$$\sum_{i=1}^{n} \mu_i(x \in X) = 1, \quad (1)$$

where x is the value of the parameter; n is the number of possible states of the parameter; X is a set of parameter states; $\mu_i(x)$ is a membership function of the parameter belonging to the i-th fuzzy set.

The consequence of expression (1) is that the i-th membership function of belonging to the corresponding i-th state becomes a complement to the set of functions of belonging to all other states, for example:

$$\sum_{i=1}^{n-1} \mu_i(x \in X) = 1 - \mu_n(x \in X). \quad (2)$$

It is worth noting that there can be no degree of belonging to emptiness. But, a situation is possible in which the variable cannot be determined, then it can be assumed that x_0 = NULL or an unknown value. The existence of an unknown or empty parameter value is possible when it is impossible to determine it or there is a complete absence of any statistical data. All possible parameter values of any complex system will be modelled by a linguistic variable. At the same time, there cannot be unknown values of linguistic variables. In order to formalize this possibility, the concept of programming – NULL – membership (belonging) was used [11].

The value of the parameter can be specified by a clear number $x = x_0$ when it belongs to one state from a set of existing states. This state is characterized by the membership function $\mu_i(x=x_0)$. However, the value of the parameter can

be characterized by an interval or a fuzzy number. In this case, the degree of belonging to each or one of the states, as well as the probability of making a decision about its belonging to the selected state, can be considered as a characteristic of the parameter. The first characteristic belongs to the theory of fuzzy sets, and the second one to the theory of probabilities. Each of the above concepts describes the degree of knowledge or ignorance about the true position of the parameter. Deciding whether a clear parameter should belong to any of the states is an event that has a probabilistic nature, so the probability of belonging to one or another state can serve as an additional characteristic of a vague parameter. The probability of belonging of a parameter that has a clear value $x = x_0$ of state M, which has a membership function $\mu_i(x = x_0)$ should be estimated. To perform this task, the method of dividing a fuzzy number at the α-level is most often used [12]. The probability that the parameter $x = x_0$ belongs to the state M at the level α_i is determined in accordance with the expressions:

$$\begin{gathered} P_M(x_0, \alpha_i < \mu_i(x = x_0), \mu_i(x = x_0) = 1) = 1; \\ P_M(x_0, \alpha_i < \mu_i(x = x_0), 0 < \mu_i(x = x_0) < 1) = p_i; \\ P_M(x_0, \alpha_i > \mu_i(x = x_0), \mu_i(x = x_0) > 0) = 0; \\ P_M(x_0, \alpha_i >= \mu_i(x = x_0), \mu_i(x = x_0) = 0) = 0 \end{gathered} \quad (3)$$

where α_i is the i-th alpha level; P_M is the probability that the variable x at the point x_0 belongs to the state M at the α_i-level. It should be noted that, based on the interval approach, a clear value of the parameter x_0 at the level α_i exists in the interval α_i when $\alpha_i < \mu_i(x = x_0)$ and $\mu_i(x = x_0) = 1$, therefore, the probability of belonging to state M is equal to 1. Level α_i can be below the values of the function $\mu_i(x = x_0) < 1$ and $\mu_i(x = x_0) < 1$, then a clear parameter that has a value of x_0 at the level of α_i can be attributed to another state, so the probability of belonging to the state M $P_M(x_0, \alpha_i) = p_i < 1$. The level α_i can be above the values of the function $\mu_i(x = x_0) < 1$ and $\mu_i(x = x_0) = 0$, then a clear parameter that has the value x_0 at the level α_i exists in the interval of the level α_i of the given state M, and the probability of belonging to the state M is equal to 0.

Suppose that the parameter *x* is a fuzzy number and it can belong to several fuzzy sets. In this case, the use of the classical concept of the degree of belonging to a fuzzy state from a set of states to estimate the parameter does not always give an objective result [11]. The result of the intersection of a fuzzy set (number x) with a set of fuzzy sets (numbers M_1 and M_2) is a set of fuzzy sets (fuzzy numbers *A* and *B*), which can serve as a basis for evaluating whether a parameter belongs to one or another state. In [10] fuzzy numbers *A* and *B* are compared, the probabilities of events $P(A < B)$, $P(A = B)$, $P(A > B)$ are determined. Such characteristics also do not give an idea of whether the parameter belongs to fuzzy states (*M1* and *M2*). In this case, the concept of belonging has a probabilistic nature, so it can be about the probability of belonging of one fuzzy number to another. A parameter that is not precisely defined is formally described by a fuzzy number *x*. A precisely undetermined parameter is formally described by a fuzzy number *x*. This number is represented by the membership function $\mu(x)$, of various shapes – triangular, trapezoidal or any other. In the general case, both the value of the parameter x and the membership function are functions of time $x(t)$, $\mu(x, t)$. It should be noted that the membership function takes into account the value of the parameter *x* when $\mu(x, t) > 0$ is fulfilled. The occurrence of another condition will be considered impossible (with a probability equal to 0). In accordance with the definition of the empty set and the above-mentioned possible values of the linguistic variable, such values can be characterized by NULL-belonging. It can be concluded that the region of possible or admissible clear values of a parameter that has a membership function that satisfies the condition $\mu(x, t) > 0$ with probability $P(x, \mu(x,t)) > 0)) = 1$ forms fuzzy characteristic of the parameter.

To analyse the level of belonging, as well as probabilistic characteristics of fuzzy data, the division of numbers on the α-level is used [10]. At the same time, intervals are compared, which are determined at a certain α-level of fuzzy numbers. Based on the results of such a comparison, it is possible to draw a conclusion about the probability of belonging or not belonging of one fuzzy number to another. The probabilities of a fuzzy parameter belonging to two fuzzy sets can be determined in accordance with [11] using the formulas:

$$\begin{gathered} P_{M1}(x = x_i) = \mu_1(x = x_i) p(x = x_i); \\ P_{M2}(x = x_i) = \mu_2(x = x_i) p(x = x_i). \end{gathered} \quad (4)$$

where P_{M1}, P_{M2} are the probabilities of fuzzy parameter x belonging to two fuzzy sets; x_i is the current value of the parameter; $p(x=x_i)$ is the probability of the event $x=x_i$. The probability that the parameter $x \in x_i$ belongs to the M_1 state at the α_j level can be determined by the formula [13]:

$$P_{M1}(x \in x_i, \alpha_j) = P(x \in x_i) P(\alpha_j), \quad (5)$$

where $P(x \in x_i)$ is the probability that the parameter x belongs to the interval x_i; $P(\alpha_j)$ is the probability of the α_j-level; $P_{M1}(x \in x_i, \alpha_j)$ is the probability that the parameter x belongs to the set M_1 at the level α_j. Since the values of α are chosen randomly, the probability that the level set α_j is chosen is $P(\alpha_j) = \alpha_j - \alpha_{j-1}$. Then, the probability that the fuzzy variable $x \in x_i$ belongs to the fuzzy state M_1 at all possible α-levels is determined in accordance with the expression:

$$P_{M1}(x \in x_i) = \sum_{j=1}^{n} (\alpha_j - \alpha_{j-1}) P(x \in x_i), \quad (6)$$

or

$$P_{M1}(x \in x_i) = \alpha_n P(x \in x_i) \quad (7)$$

where *n* is the number of α-levels. Based on the fact that $\alpha_n = \mu_1(x = x_i)$ and taking into account expression (4):

$$P_{M1}(x \in x_i) = \mu_1(x = x_i) \mu(x = x_i) \Delta p(x = x_i), \quad (8)$$

where $\Delta p(x = x_i)$ is the probability of occurrence of the event $x = x_i$ in the interval Δx. Then, the membership of two fuzzy sets of the fuzzy parameter *x* is estimated by the clear probability and is calculated by the formulas:

$$\begin{gathered} P_{M1}(x) = \sum_{i=0}^{n} \mu_1(x_i) \mu(x_i) \Delta p(x_i); \\ P_{M2}(x) = \sum_{i=0}^{n} \mu_2(x_i) \mu(x_i) \Delta p(x_i). \end{gathered} \quad (9)$$

Moving on to the continuous representation of variables, the probability of a fuzzy number belonging to two fuzzy states can be determined:

$$P_{M1}(x) = \int_0^1 \mu_1(x)\mu(x)dp$$
$$P_{M2}(x) = \int_0^1 \mu_2(x)\mu(x)dp. \quad (10)$$

With a uniform distribution of a random variable, the interval Δp is determined by the formula:

$$\Delta p = \Delta x/(x_k - x_0), \quad (11)$$

where x_0 is the lower limit of the interval $[x_0, x_k]$ of the parameter x; x_k is the upper limit of the interval $[x_0, x_k]$ of the parameter x. After replacing the variable according to (11):

$$P_{M1}(x) = \frac{1}{x_k - x_0}\int_{x_0}^{x_k} \mu_1(x)\mu(x)dx;$$
$$P_{M2}(x) = \frac{1}{x_k - x_0}\int_{x_0}^{x_k} \mu_2(x)\mu(x)dx. \quad (12)$$

The sum of the probabilities of a fuzzy parameter belonging to two fuzzy states is equal to 1:

$$P_{M1} + P_{M2} == \frac{1}{x_k - x_0}\int_{x_0}^{x_k} \mu_1(x) + \mu_2(x))\mu(x)dx. \quad (13)$$

Taking (2) into account:

$$P_{M1} + P_{M2} == \frac{1}{x_k - x_0}\int_{x_0}^{x_k} \mu(x)dx. \quad (14)$$

Based on (4):

$$\int_{x_0}^{x_k}(x)dx = x_k - x_0, \quad (15)$$

Then the expression (13) is transformed into the form:

$$P_{M1} + P_{M2} = 1. \quad (16)$$

On the basis of the obtained expressions (4), (12), the probability of fuzzy values of the parameter (indicator) belonging to its possible fuzzy states is determined. This makes it possible to formalize conceptual components from the standpoint of fuzzy logic; to compare fuzzy parameters of different nature and measurement units; evaluate the state of parameters in the absence of statistical data.

In order to assess the impact of a regulatory legal act on the activity of the enterprise, the following assumptions should be made: the norm of law may or may not be used for corruption purposes; with an increase in the probability of using the norm for corrupt purposes, the belonging to this norm to the set of corrupt ones increases; since there is no statistic of the membership function μ(*x*) of law norms to the set of corrupt ones, they should be considered as an equivalent; the function *M(x)* of the simultaneous belonging also of norms $\mu_i(x)$ to the set of possible non-corrupt actions is determined according to the expression [14]:

$$M(x) = \prod(1 - \mu_i(x)). \quad (17)$$

Development of a model for the process of assessing the corruption orientation of a regulatory legal act. The assessment of the corruption of regulatory legal acts and their actions requires complex knowledge and the application of methods of both legal science and sociological, general scientific, statistical and other methods. In modern research, the theory of fuzzy sets is widely used both in technology and in economics. It has a developed mathematical apparatus and is used to solve complex problems in which statistical data cannot be obtained. However, these methods are practically not used to analyse RLA corruption. In order to use fuzzy set methods to assess the corruption of RLAs, it is necessary to perform the following stages [15]: to determine the indicators that can affect the level of corruption of RLAs; to establish the level of influence of the indicator on the corruption of the RLA; to build indicator classification levels; to evaluate the current level of each indicator; to classify the current level of indicators; to establish the general indicator of corruption of the RLA; to determine the current level of the general indicator of corruption of the RLA. Quantitative analysis of RLA corruption is based on the selection of objective indicators that describe various aspects of this phenomenon. They, on the one hand, influence the assessment of corruption of the RLA, and on the other hand, assess the level of its maturity [16]. A set of indicators $Y = \{y_i\}$ of N number should be formed.

The indicators the level of influence on the corruption of the RLA or the level of significance of each are assigned. To simplify the evaluation process, it should be assumed that the indicators have the same weight or have the same effect on the assessment of the corruption of the RLA. Levels by which the values of indicators can be classified are formed. For the ui indicator, which will characterize the probability of the occurrence of factors contributing to the corruption of the RLA, the full set of its values is divided into several subsets: y_{i1} – the subset "low level of support for RLA corruption"; y_{i2} – the subset "average level of promoting RLA corruption"; y_{i3} – the subset "high level of promoting RLA corruption"; y_{i4} – the subset "very high level of promoting RLA corruption". Moreover, it can be assumed by default that the increase in indicators is connected with the increase in corruption of the RLA. Based on these definitions, the classification levels for indicators are set (Table 1).

Table 1. Levels of classification of values of the probability of occurrence of factors contributing to the corruption of RLAs

Levels of classification	The name of the subset
$0.75 < y_{14} < 1$	Very high level of promoting RLA corruption
$0.5 < y_{13} < 0.75$	High level of promoting RLA corruption
$0.25 < y_{12} < 0.5$	Average level of promoting RLA corruption
$y_{11} < 0.25$	Low level of support for RLA corruption

Source: developed by the author

Table 1 defines the clear limits of the classification levels of the values of each indicator. When forming fuzzy levels of classification of indicators, it is necessary to specify their fuzzy subsets with overlapping boundaries. For example, each of these subsets can be given by a number that has the form of a trapezoid (Fig. 1).

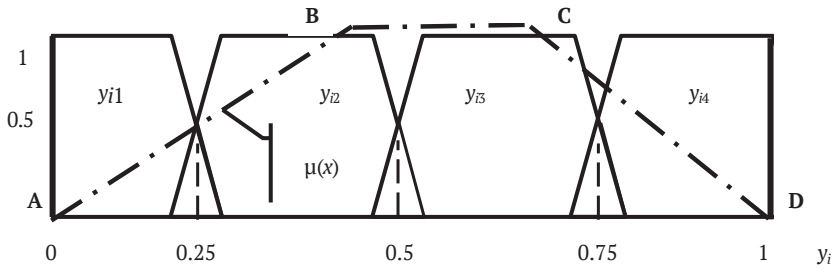

Figure 1. Levels of classification of values of the probability of occurrence for factors contributing to the corruption of RLAs

Source: developed by the author

At the next stage, the probability of the function μ(x) (trapezoid ABCD) (Fig. 1) is determined to each of the possible states of the factor according to formula (12). At the stage of establishing the integral indicator of RLA corruption, it should be defined as the probability of belonging to one of the states of the set of independent factors according to the expression [16]:

$$Pi=\sum_k \prod_j p_{jk}, i=1..Z, \quad (18)$$

where Z is the number of possible fuzzy states of the integral indicator; P_i is the probability of the integral indicator belonging to the i-th state; p_{jk} is the probability of the j-th indicator belonging to the k-th state. The Z value is determined according to the degree of detail of the assessment, while the level of classification of the indicator values can be set similarly to Figure 1. But it is also possible to stop on only three states (low, medium and high). As a result, according to each of the states, we will get numbers that characterize the level of promotion of corruption by the RLA.

RESULTS AND DISCUSSION

The definition of promoting corruption should be considered using the example of the regulatory legal act on the reclamation of forestry lands disturbed as a result of amber mining [17]. At the first stage, a set of individual indicators that affect the assessment of the corruption of the RLA is determined. For this purpose, Table 2 shows the responsibilities stipulated by the example of the contract between the customer and the contractor, and their corruption risks are assessed. The "Description" column lists the factors from the source [18]. It should be assumed that the level of influence of each indicator (factor) on the assessment of RLA corruption is equivalent.

Table 2. Factors provided by the example of the contract between the customer and the contractor and assessment of their risks

No.	Description	Risk
1	During the geological study, including the experimental and industrial development of amber, 100% of the discovered amber is recovered during the experimental and industrial development	Concealment of the discovery of minerals and development of land intended for reclamation
2	Reproduction of forests on reclaimed land	Lack of the desired result
3	The possibility of involving third parties and contractors	Transferring responsibility for breach of contract, its non-fulfilment to third parties
4	In the course of the work, ensure that employees comply with the requirements of nature protection, forest and land legislation, norms, rules of labour protection, man-made and fire safety	Non-compliance with norms and rules
5	The Customer does not have the right to make any claims regarding any property received by the Contractor during the exercise of his powers	Obstructing the work of the customer

Source: developed by the authors basing on [18]

The classification levels of the values of each of the five indicators in accordance with Figure 1 were constructed. The current level of belonging to the promotion of corruption of each of the indicators is evaluated. To do this, their membership functions $\mu_i(x)$, $i = 1, \ldots 5$ were defined. The first indicator (factor) of concealing the fact of the discovery of minerals and the development of land intended for reclamation greatly affects the promotion of corruption in the RLA.

According to [19-20] it should be determined that with the probability of using the norm for corruption purposes starting from 0.5, the function of belonging to this can be set to 1 ($\mu_1(x) = 1$). If this probability is less than 0.5, then the function $\mu_1(x)$ can be considered linear in the range from 0 to 1. Then it will have the following form: $\mu_1(x) = 2x$ (Fig. 2).

The formation of the functions of belonging to the promotion of corruption of each of the last four indicators (Table 2) in view of the absence of information can be based only on the assumption of its linear dependence on the probability of occurrence of this event [18].In this case, this function will have the following form: $\mu_2(x) = x$ or $\mu_i(x)$, $i = 2, 3, 4, 5$ (Fig. 2). The results of the calculation according to formula (12) of the probability of function $\mu_i(x)$ belonging to each of the possible states or levels of factor classification are shown in Table 3.

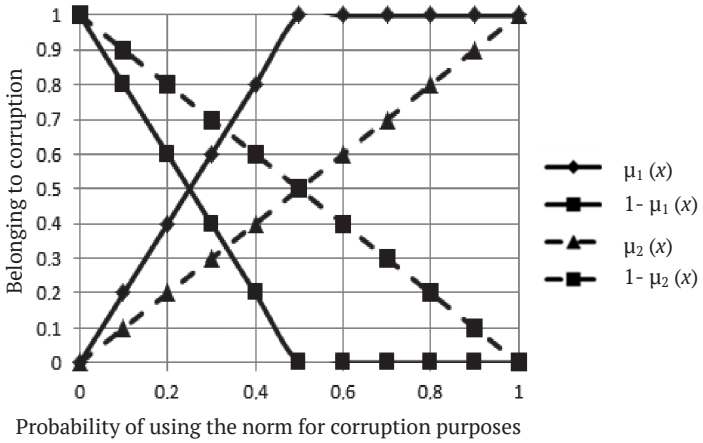

Figure 2. Functions of belonging to the promotion of corruption

Source: created by the authors basing on [18]

Table 3. Probability of belonging to the factors contributing to the corruption of the RLA to the levels of classification of the values of y_i

Factors contributing to RLA corruption	Levels of classification			
	y_1	y_2	y_3	y_4
Factor 1	0.09	0.23	0.34	0.34
Factor 2 (3, 4, 5)	0.072	0.192	0.314	0.422

Source: developed by the authors

An indicator of the promotion of corruption by the RLA is formed. At the same time, it should be assumed that it has three states (from a low to a high level of promoting RLA corruption), the classification levels of which are shown in Table 4.

It should be noted that all membership functions are defined rather conditionally or on the basis of expert assessments. In order to eliminate such an element of bias in the definition of membership functions, it is possible to create several rules for the formation of integral indicators of the level of belonging to each of the three states of RLA corruption. In the example, two variants of rule formation are considered. For example, the hard and soft versions of the rules are shown in Table 5.

Table 4. Levels of classification of the probability of promoting corruption by the RLA

Levels of classification	Name of indicator states
$0.70.05<y_в<1$	High level of promotion of RLA corruption
$0.30.05<y_c<0.7+0.05$	Average level of promoting RLA corruption
$y_н<0.3+0.05$	Low level of promotion of RLA corruption

Source: developed by the authors

Table 5. Rules for determining the probability of belonging to the levels of promoting corruption by RLA

State	A strict version of the rule	A soft version of the rule
High level of corruption	Only one indicator has a high or very high level of promoting corruption, the others are the norm	Two of the factors have a high or very high level of promoting corruption, and the others are the norm
Low level of corruption	Three indicators out of five have a low level of promoting corruption, the others are not above the norm	Two indicators out of five have a low level of promoting corruption, the others are not above the norm
Average level of corruption	In all other cases	In all other cases

Source: developed by the authors

Based on the above considerations, the limit values of clear intervals of the probability of RLA belonging to low $[P^1_{H1}-P^1_{H2}]=[0.219-0.287]$, medium $[P^1_{C1}-P^1_{C2}]=[0.38-0.42]$ and high $[P^1_{B1} - P^1_{B2}] = [0.293 - 0.401]$ intervals can be determined.

Determining the corruption orientation of the RLA requires taking into account heuristic data, which have a very high level of uncertainty and cannot be formalized by means of analytical-stochastic modelling. The lack of the possibility of obtaining statistical data does not allow the methods proposed in works [3-6] to be used to solve the problems of assessing the state of complex systems, which are characterized by many heuristic indicators. In addition, predicting changes in some indicators can be very problematic or simply impossible. Therefore, obtaining initial data for processing the results of assessing the level

of corruption orientation of the RLA by the methods outlined in [7; 9-10] needs additional research. The methodology outlined in work [2] is directly devoted to assessing the corruption risk of RLA, it is based on heuristic expert assessments and some initial data can be used in this study.

Methodology [2] assesses two components of corruption risk. This is the corruption risk, which is assessed by three levels (low, medium or high) and the levels of possible consequences of the corruption offense (low, medium or high). Accordingly, the numbers 1, 2, 3 are assigned to each level (low, medium, high). Corruption risk is defined as the product of the level of the occurrence of corruption risk by the level of the consequence of a corruption offense. At the same time, a scale is established by which the corruption risk is determined (Table 6) [2].

Table 7 shows an example of applying the methodology [2] when determining each of the components and the overall level of corruption risk in accordance with the regulatory legal act on the reclamation of forestry lands disturbed as a result of amber mining.

Table 6. Degrees of corruption risk

Risk level	Risk assessment
Low	from 1 to 2 points
Middle	from 3 to 4 points
high	from 6 to 9 points

Source: [2]

Table 7. Determination of the level of corruption risk

Risks	Probability of an offense related to corruption (points)	Consequences of an offense related to corruption (points)	Degree of corruption risk	Level of corruption risk
Indicator 1	2	3	6	High
Indicator 2	1	2	2	Low
Indicator 3	2	2	4	Average
Indicator 4	3	3	9	High
Indicator 5	2	2	4	Average

Source: developed by the authors based on [2]

According to the rules (Table 5), this regulatory act belongs to a high level of corruption promotion for both hard and soft variants of the formation of the integral indicator, since two indicators have a high level. Based on the results obtained when determining the intervals $[P^1_{H1} - P^1_{H2}]$, $[P^1_{C1} - P^1_{C2}]$, $[P^1_{B1} - P^1_{B2}]$ during the conducted research, it can be concluded that this RLA rather belongs to the medium level of promoting corruption.

It should be emphasized that the approach [2] to the formalization of corruption risks has significant shortcomings in the formation of a global criterion, which can lead to systematic erroneous assessment results:

- the scale for determining the degree of corruption risks is not continuous (it is impossible to assess risks with scores of 5, 7, 8), this reduces the reliability of decision-making results;
- the results of comparing different degrees of corruption risks cannot characterize their real difference, for example, the difference between a high and an average degree of risk is 2 points, and two values of a high degree of risk can differ by only 3 points;
- a low level of corruption risk for any of the components (1 point) does not affect the overall degree of corruption risk;
- a large number of parameters and a high level of their uncertainty are not taken into account;
- clear boundaries are established between the difference in risk levels for all possible assessments, although the task of assessing the level of corruption risk has a fuzzy nature.

To eliminate these shortcomings, a fuzzy-set approach to the analysis of corruption risk of RLA is used. Each data obtained by processing partially or fully heuristic information has a fuzzy nature. Therefore, the representation of numerical information by an interval or a fuzzy value more objectively describes the characteristics of the subject area. However, when forming the membership functions of the indicators, the level of their uncertainty should also be taken into account. In view of this, the values of the probability intervals of RLA belonging to the low $[P^1_{H1} - P^1_{H2}] = [0.219 - 0.287]$, medium $[P^1_{C1} - P^1_{C2}] = [0.38 - 0.42]$ and high $[P^1_{B1} - P^1_{B2}] = [0.293 - 0.401]$ levels can be performed to compare the promotion of RLA corruption. For example, having set the membership function $\mu_2(x) = \mu_1(x)$, the following interval values can be achieved: low $[P^2_{H1} - P^2_{H2}] = [0.196 - 0.23]$, medium $[P^2_{C1} - P^2_{C2}] = [0.385 - 0.43]$ and high $[P^2_{B1} - P^2_{B2}] = [0.34 - 0.419]$. Comparison of intervals can be performed based on the methodology [12]. Accordingly, the probability of exceeding one interval over another is determined [12]. The results of comparing the intervals of probability values of the RLA belonging to the low, medium and high levels are shown in Table 8.

Table 8. The probability of exceeding the intervals

$[P^2_{H1}-P^2_{H2}]>[P^1_{H1}-P^1_{H2}]$	$[P^2_{C1}-P^2_{C2}]>[P^1_{C1}-P^1_{C2}]$	$[P^2_{B1}-P^2_{B2}]>[P^1_{B1}-P^1_{B2}]$
0.06136	0.68	0.565

Source: developed by the authors

Based on the obtained data, it can be concluded that the second version of the RLA significantly increases the promotion of corruption, although it differs in only one membership function out of five. The considered issue of taking into account the level of uncertainty of the membership functions of indicators requires additional research when considering a specific subject area. The example considers the main stages of the process of assessing the level of corruption promotion of the RLA, as a result of which an approximate assessment of the regulatory legal act on the reclamation of forestry lands disturbed as a result of amber mining was obtained, which requires more detailed research. In this way, the process of assessing the level of RLA in relation to the promotion of corruption is reduced to the transformation of the membership functions of each of the corruption factors into a comparison of value intervals.

CONCLUSIONS

Setting the task of assessing the level of the RLA in relation to the promotion of corruption is characterized by a large number and uncertainty of private criteria, their inequality, as well as antagonism. At the same time, it is very important to simultaneously take into account criteria that are based on subjective assessments and have uncertainties of various nature. This leads to the need to process partially or completely heuristic information that cannot be described by clear numerical values. Therefore, the representation of numerical information by an interval or a fuzzy value more objectively describes the characteristics of the subject area.

The work examines in detail the stages of the process of evaluating the corruption orientation of regulatory legal acts. At the same time, it is possible to obtain a quantitative assessment of the negativity of the legislation. The determination of the level of corruption promotion is considered on the example of the legal act on the reclamation of forestry lands disturbed as a result of amber mining. The limit values of clear intervals of probability of RLA belonging to low, medium, and high levels are determined. The question of possible change of the initial data regarding the rules for the formation of the global criterion for deciding on the level of promotion of RLA corruption is considered. The research results are obtained on the basis of modelling using the methods of probability theory, fuzzy sets, and fuzzy logical inference. The proposed approach to assessing the level of RLA in relation to the promotion of corruption has the following features and advantages: the initial data can be presented as clear and fuzzy numbers; private criteria of a different nature are reduced to some relative units, which simplifies the convolution to a global quality indicator; there is no need to determine the weight of each individual indicator; the use of expert evaluations is minimized (only when creating membership functions); the method can be used both to compare the corruption orientation of regulatory and legal acts, and to determine its relative change. For the further development of this work, it is planned to carry out research on the accounting of possible financial losses, which is an additional incentive for the emergence of RLA corruption.

REFERENCES

[1] Law of Ukraine No. 1811-IX "On Prevention of Corruption". (2010, October). Retrieved from https://zakon.rada.gov.ua/laws/show/1811-20#n271.

[2] Draft of corruption risk management methodology. (2021). Retrieved from https://nazk.gov.ua/uk/documents/metodologiya-upravlinnya-koruptsijnymy-ryzykamy/.

[3] Druzhinin, S.V., & Klymovych, O.K. (2018). The mobility assessment model of the special purpose information and telecommunication network. *Collection of scientific works of the Kharkiv National University of the Air Force*, 1, 107-110.

[4] Dodonov, A., Gorbachyk, O., & Kuznietsova, M. (2018). Increasing the survivability of automated systems of organizational management as a way to security of critical infrastructures. *Information Technologies and Security*, 24(1), 74-81.

[5] Khudov, H., Khizhnyak, I., Koval, V., Maliuha, V., Zvonko, A., Yunda, V., Nagachevskyi, V., & Berezanskyi, V. (2020). The efficiency estimation method of joint search and detection of objects for surveillance technical systems. *International Journal of Emerging Trends in Engineering Research*, 8(3), 813-819. doi: 10.30534/ijeter/2020/34832020.

[6] Havrys, A.P. (2018). *Models and methods of forming portfolios of flood protection projects*. (Candidate's thesis, Taras Shevchenko Kyiv National University, Kyiv, Ukraine).

[7] Malyshko, Yu.M. (2016). *Assessment and neutralization of the negative impact of administrative barriers on small business*. (Candidate's thesis, Scientific and Research Center for Industrial Problems of development of the NAS of Ukraine, Kharkiv, Ukraine).

[8] Laptiev, O., Shuklin, G., Hohonianc, S., Zidan, A., & Salanda, I. (2019). Dynamic model of cyber defense diagnostics of information systems with the use of fuzzy technologies. In *2019 IEEE international conference on advanced trends in information theory* (pp. 116-119). Kyiv: Taras Shevchenko National University of Kyiv. doi: 10.1109/atit49449.2019.9030465.

[9] Dubois, D., & Koenig, J.L. (2017). Social choice axioms for fuzzy set aggregation. *Fuzzy Sets and Systems*, 43, 257-274. doi: 10.1016/0165-0114(91)90254-N.

[10] Malyshko, Yu.M., & Losev, M.Yu. (2015). Fuzzy-multiple estimation of the state of parameters of technical and economic systems. *Collection of scientific works of the Kharkiv National University of the Air Force*, 4(129), 33-38.
[11] Kononov, N.Yu., & Loseva, Yu.M. (2015). *The method of multi-criteria assessment of the state of techno-economic systems based on the fuzzy-multiple analysis of indicators*. Kharkiv: Kharkiv National University of the Air Force.
[12] Kondratenko, Yu.P., Kondratenko, G.V., & Sidenko, Y.V. (2019). *Fuzzy multipliers and fuzzy logic*. Mykolaiv: Chornomorsk National University named after Peter Mohyla.
[13] Zayats, V.M., Rybytska, O.M., & Zayats, M.M. (2017). Hidden possibilities of mathematics in processing vague information. *Radioelectronics & Informatics*, 4, 64-71. doi: 10.30837/1563-0064.4(79).2017.152305.
[14] Ponomarenka, V.S. (Ed.). (2019). *Information systems and technologies*. Kharkiv: "Stil-izdat" LLC.
[15] Ponomarenka, V.S. (Ed.). (2017). *Information technologies: Problems and prospects*. Kharkiv: S.G. Rozhko Publishing.
[16] Bojadziev, G., & Bojadziev, M. (2017). *Fuzzy logic for business, finance and management*. Singapore: World Scientific Publishing.
[17] Proposals of the State Service of Ukraine for Geodesy, Cartography and Cadastre to the Draft of Law of Ukraine No. 2366 "On the Reclamation of Forestry Land Disturbed as a Result of Amber Mining". (2019, November). Retrieved from https://www.kmu.gov.ua/storage/app/bills_documents/document-1510017.pdf.
[18] Daugul, V., & Aleksenko, A. (2018). *Current issues of agricultural land use by local self-government bodies*. Kharkiv: Factor.
[19] Dudorov, O.O., Komarnytskyi, M.V., & Kalmykov, D.O. (2016). *Criminal liability for illegal mineral extraction in Ukraine*. Sumy: Luhansk State University of Internal Affairs named after E.O. Didorenko.
[20] Shust, G.P. (2019). *Administrative and legal protection of land resources of Ukraine*. (Candidate's thesis, West Ukrainian National University, Ternopil, Ukraine).

Моделювання процесу оцінювання корупційної спрямованості нормативно-правових актів

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Анотація. В умовах зростаючих вимог до методів і засобів боротьби з негативними явищами суспільства профілактика та попередження корупційних дій посадових осіб шляхом створення нових і редагування старих нормативно-правових актів може суттєво обмежити розвиток таких правопорушень та позитивно вплинути на економічний стан держави. Актуальним завданням є розроблення простих і ефективних методів моделювання і оцінювання рівня корупційної спрямованості нормативно-правових актів. В роботі розглядається проблема кількісного оцінювання негативного явища корупційної діяльності посадових осіб, яка може бути стимульована нормативно-правовими актами. Мета статті – удосконалення методів і методик аналізу процесу оцінювання якості нормативно-правових актів шляхом моделювання їх корупційної спрямованості. В процесі моделювання кількісного оцінювання рівня корупційної спрямованості нормативно-правових актів використовуються методи теорії нечітких множин та нечіткого логічного висновку, а також методи теорії ймовірностей. Пропонований підхід дозволяє одночасно враховувати окремі критерії, які засновані на суб'єктивних оцінках і мають невизначеність різної природи, а також характеризуються великою кількістю, їх нерівнозначністю і антагоністичністю. При цьому процес моделювання забезпечує можливість використання як чіткого, так і нечіткого представлення вихідних даних, зменшує вплив суб'єктивності експертних оцінок на фактори евристичного характеру. При формуванні глобального критерію прийняття рішення про рівень корупційної спрямованості нормативно-правового акту немає необхідності визначати вагу кожного окремого фактору. На основі отриманих значень глобального критерію приймається рішення про вибір того чи іншого варіанту нормативно-правового акту. У роботі розглянуті етапи реалізації запропонованого підходу до оцінювання рівня корупційної спрямованості нормативно-правового акту про рекультивацію земель лісогосподарського призначення, порушених в наслідок видобутку бурштину. Результати роботи можуть бути корисними при розробці проектів нового законодавства, а також для дослідників методів контролю і управління складними техніко-економічними системами

Ключові слова: нечітка множина, функція приналежності, лінгвістична змінна, показник якості, випадкова величина, ймовірність приналежності

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Quality management technologies of railway transport services

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Abstract. The relevance of the research topic is stipulated by the crisis phenomena that are taking place in the development of the transport industry of Ukraine, which are caused both by the aggravation of internal contradictions in the development of subjects of this sphere, and by the influence of external negative factors related to the economic and political crisis in the country. The purpose of the work was to determine the problems of managing the quality of services provided in railway transport sector. The features of modern transport services have been determined, the issue of effective training of personnel in the conditions of using advanced training technologies has been raised, and the characteristics of the provision of services by JSC "Ukrzaliznytsia" has been provided. Based on economic-mathematical models, it has been proven that the profit dynamics of railway transport enterprises depends to a large extent not only on their technical and technological capabilities, but also on socio-economic factors regarding the need and possibility of using technologies for managing the quality of services. It has been determined that the above-mentioned discrepancies and problems significantly affect the level of service quality management technology of enterprises in this sector. A conclusion has been made about the need to increase the efficiency of service quality management technology of railway transport enterprises based on the use of modern approaches to the comprehensive study of consumer needs and further improvement of consumer qualities of transport services in order to generate profit, increase the social significance of railway transport and obtain competitive advantages in the future. The results of the study can be used to develop a state strategy for regional development, as well as to devise plans and recommendations for the development of railway transport enterprises at different levels of management

Keywords: enterprises, railway industry, standard forecasting, management

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INTRODUCTION

As a result of the aggravation of internal conflicts within the subjects of this sphere's development as well as the influence of externally harmful factors linked to economic and political instability in the nation and the world, Ukraine's transport industry is currently facing extremely challenging times. But the development of transport infrastructure, which is essential for nearly all sectors of the national economy, is closely related to Ukraine's economic situation. In turn, in order to develop the railway transport, it is necessary to resolve concerns with Ukraine's railway industry's integration into the European transport system and raise the standard of services offered by businesses. The processes of globalization and Ukraine's integration into the global economy necessitate new approaches to managing Ukraine's transport system, in which railway transport has always played a crucial role and continues to do so. This is due to Ukraine's significant potential for transit and one of the largest rail networks in Europe. Effective management of the level of services, provided by railway transport companies, promotes national economic growth and the resolution of several social and economic issues. The management of railway transport firms must thus continuously enhance the forms and methods of management due to the complexity and instability of the macroeconomic environment.

Although the structure of service quality management technology in its many forms and techniques is primarily a practical endeavour, there is a substantial theoretical and scientific foundation for the analysis, which has been provided in the research of several scientists from both Ukraine and abroad. In-depth examinations of the evolution of the idea of BPM (business process management)

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are offered by H.A. Reijers [1]. The practical and theoretical recommendations for using the concept of TQM (total quality management) were published in the works of I. Othman [2] and J.L. Roldan [3]. H. Obruch [4] studied service quality management in transport companies. The article by M. Garayev [5] examines the essence of transport services at the current stage, when railway transport of Ukraine is a part of the global transport system. Principles of the theory of production optimization at the level of small and medium-sized enterprises have been analysed by K. Antosz [6]. E. Nedeliakova's [7-8] research provides the analysis of current developments in the field of process-based quality management. The work of I. Stravinskiene & D. Serafinas [9] is particularly notable as it offers a systematic investigation and comparative analysis of quality management principles and business procedure management. It also looks for the methodical place of business process administration within the framework of a quality management system. The potential use of IT tools in the process of quality management in the field of service delivery is examined in R. Jankala's work [10], which is justified by the dynamism of the service market and the significance of the service "quality" attribute in the context of ensuring the survival of players in this market. The presence of a significant theoretical-methodological basis in the field of organizing the process of quality management technology determines the relevance and need for a certain structuring of the accumulated knowledge, as well as the demarcation of the problem field of the analysed area. The purpose of this work was to solve the problems of quality management of railway transport services.

MATERIALS AND METHODS

The research methodology includes the ontological analysis of the field of service quality management technology regarding the methodological toolkit of applied implementation of the main theoretical developments in this field, the method of synthesis and predictive assessment of trends in the development of service quality management technology in the conditions of the formation of a high-tech environment. The analysis of service quality management technology in the transport industry has been carried out on the example of JSC (joint-stock company) "Ukrzaliznytsia". The works of Ukrainian and other scientists served as a theoretical foundation for the present research.

In the course of conducting the study, different methods were used: statistical analysis, formalization and techno-economic analysis. Tabular and graphic methods were used to summarize the research data. This made it possible to visually compare retrospective and prospective values of quality indicators of railway transport services. A considerable amount of literature was used as research material, namely 22 sources, including the works of Ukrainian researchers and articles by researchers from other countries on this and similar issues, in order to consider the vision of the problem on a global scale and to analyse different approaches and standards, for which the analytical method was also used. The report of the State Statistical Service of Ukraine on the state of transport in Ukraine in 2020 was also analysed.

Using the methods of analysis and synthesis, various international standards have been analysed in detail, both in their individual aspects and in general, which has allowed this study to verify the importance of individual standards and the feasibility of their application to improve service quality management, using the example of railway transport companies. In order to draw conclusions of the study, the abstract-logical method was used, which is often used in articles that examine a particular sector of economic activity in the country.

RESULTS AND DISCUSSION

For the effective organization of product quality management at railway transport enterprises and the construction of a quality management system for them, it is necessary to have a clearly defined object of management, as well as defined categories of management, that is, phenomena that make it possible to better understand and organize the entire specified process. The structure of the modern quality management process consists of the following functions:

1. Quality planning: the aspect of quality management that focuses on establishing quality goals, identifying the operational procedures required, and allocating appropriate resources to attain those quality goals.

2. Quality Assurance: the function of quality management that focuses on ensuring that quality requirements are met, offering assurance in this regard.

3. Quality management: the function of quality management that is directed towards meeting quality specifications.

4. Quality improvement: a function of quality management aimed at increasing the ability to meet expectations that focuses on enhancing the capability to satisfy quality requirements [11]. The creation, functioning and development of the quality management system are carried out based on the following principles:

Customer orientation. A key stakeholder for the railway industry is the users of its services. The main categories of consumers of JSC "Ukrzaliznytsia" services are: consignors, consignees, railway rolling stock operators and passengers [11]. The current and future needs and expectations of these main categories of consumers of transport services depend on the specifics of cargo, regions of the country, the season for the provision of services and other factors. The study of the current and future needs of the main categories of consumers is carried out on an ongoing basis by the relevant divisions of transport companies. Fulfillment of customer requirements is a key objective of the operational processes of the quality management system and is ensured through the implementation of a compliance strategy. Particular attention is paid to the process of designing services based on the study of the current and future needs of the main categories of consumers [11]. The implementation of this principle at transport enterprises is carried out through the standardization of consumer requirements, monitoring their satisfaction and strict compliance with established requirements. Exceeding customer expectations is achieved through the implementation of a continuous improvement strategy.

Leadership. The leaders of transport companies ensure the unity of purpose and direction of the company. They establish and uphold an internal atmosphere where employees can actively engage in the organization's tasks. The effectiveness of the quality management system is

determined by the personal responsibility and degree of participation of managers at all levels of management in its creation, operation, and development. The leaders of transport companies at all levels should move from the system of control, coercion, and punishment to the system of setting agreed goals based on the strategic goals of the company, create an environment for involving all employees in the process of achieving these goals and provide them with necessary resources.

Employee engagement. The transport company should consider its employees as one of the most important stakeholders and a key resource. The development of competence and advanced training of personnel is one of the main tasks of the quality management system. Creation of conditions in which the company's employees would feel economic security, could satisfy their needs for respect, recognition, and self-realization, which are priority areas in work with personnel. These priorities, along with personal motivation and employee loyalty, form the basis for engaging employees in the process of continuous improvement. The involvement of employees in the activities of a transport company is achieved through the delegation of greater independence and authority under greater responsibility and self-control, as well as the creation of an appropriate motivational environment.

The process approach is a fundamental principle of the quality management system. Managing the transport company's activities through a system of interrelated processes ensures the required level of its service quality. Comprehending and overseeing interconnected processes as a system enhances efficiency of the company's operations and ensures the successful achievement of its strategic goals, as well as the satisfaction of stakeholders' interests. In accordance with the enlarged scheme of the integrated process model, the processes of the quality management system, located in the automated control system for modeling business processes, include management processes, core business processes and supporting processes [11]. Process management is performed by process owners. The quality management system establishes the roles, powers, responsibilities, and interactions of process owners. A system of key process performance indicators is established to monitor and manage each process.

Continuous improvement of activities. The principle of continuous improvement of the transport company's activities is implemented through the elimination of the causes of identified inconsistencies and problems in the company's processes with the help of corrective actions, as well as through the continuous improvement of process capabilities (the ultimate ability of processes to achieve results). The main approach to continuous improvement is the implementation of risk management, which involves the identification and assessment of risks, as well as the choice of methods and tools to minimize the identified risks. This is especially true when it comes to ensuring the security of provided services [9]. The implementation of the principle of continuous improvement also implies the creation of an internal environment that provides for the opening of improvement projects, the motivation of employees to work in project teams and the rewarding of project team members. Continual improvement can be applied to: indicators of products and services; indicators of the results of production processes; indicators of the results of management processes [11].

Evidence-based decision making. To obtain objective evidence, the transport company's factual data related to its activities are analyzed using modern methods, such as Pareto analysis, Ishikawa chart, histogram, special graphs, etc. [11]. All management decisions in the transport company are based on the obtained objective evidence, documented in the prescribed manner.

Relationship management. Management decisions in the transport company are made based on determining the satisfaction of interests of all parties involved: shareholders, state, society, end consumers, suppliers and employees of the transport company, etc., taking into account the balance of interests. Satisfying the interests of stakeholders is implemented through a system of strategic planning and goal setting, considering the balance of interests. The system of goals and their achievement is guided by the priority of stakeholders' strategic interests. Transport companies build long-term mutually beneficial relationships with suppliers based on information transparency, improving the procedure for jointly solving problems related to the operational and economic characteristics of the products or services supplied.

In the last quarter of the 20th century, Europe turned most actively to solving the problem of Quality Management to Quality of Management [12]. The ISO 9000 family of standards has been developed to help companies, regardless of their profile of activity and size, implement effective quality management systems (QMS). According to the International Organization for Standardization in 159 countries, over 560,000 certificates have been issued for quality management systems [12]. The updated version of the series includes: ISO 9000; QMS; basic provisions and vocabulary. It introduces quality management systems and a glossary of terms and definitions.

ISO 9001. QMS. Requirements. It establishes requirements for quality management systems. ISO 9004. QMS. Performance Improvement Guide. The further development of the constructed quality management system is considered to achieve continuous improvement of business activities and organization management on the principles of TQM. ISO 19011 Companion standard. It provides the guidelines for conducting audits of the quality management system, as well as the requirements for auditors. ISO 10012 Companion standard. It defines requirements for instrumentation and test equipment.

A company capable of presenting a certificate of the ISO 9000 series has the most undeniable recommendation, since the certificate for compliance with ISO 9000 standards is an official confirmation of the quality assurance of products, works and services [12]. ISO 9000 certification is a token of the company's dynamic development, which suggests its value in the eyes of potential customers and partners. Almost 100% of IT companies' offices are decorated with ISO 9000 series certificate, conveying the image of "companies of the future". ISO standards are advisory. However, some standards (for example, on health, safety, environmental protection) are adopted by several countries as mandatory [12]. Successful management is achieved by implementing and maintaining an appropriate management system that is designed to continually improve

performance. The purposes of the quality system are as follows: to improve the enterprise's activity; to ensure customers' confidence in the quality of the products received.

In accordance with the ISO 9000 family of standards the quality management system of foreign railways is based on four principles [12]:

1. Quality standard: development and approval of the standard; development and approval of the standard for tools; commissions on quality standards and methods.

2. Quality monitoring: quality monitoring through a quality information system with operational control; evaluation of projects and activities; coordination of quality projects in the company.

3. Quality audit: audit of production processes on the instructions of the company's board; audit of the product (services) on the instructions of the board.

4. Quality assurance: procurement quality system; means of quality control; registration of quality change.

The quality monitoring used in operational work implies almost in the first place: monitoring the degree of customer satisfaction with the company's services; monitoring the demand for services, including new ones; monitoring the quality of production and operational processes (schedule execution, accuracy of arrival, etc.). Quality monitoring on railways is temporary: daily, weekly, etc.

American railroads have been implementing ISO 9000 series standards since 1996 and are now adopted by almost all railroad departments. The indicator of one worker per kilometer of railroad tracks in America is one measure of performance. The foundation of the United States railroad quality system is the M-1003 regulation, which is one of the subsections (subsection "J") of the Standards and Recommended Practices Manual (MSRP). This document is updated regularly. The work on its adjustment and updating is carried out under the general supervision of the Technical Committees of the Azerbaijan Railways with the active participation of the Department of Technical Inspections of the Center for Transport Technologies [13]. Monitoring is carried out based on automated control systems, which are available for almost all types of activities. Apart from performing their specific tasks, these automated control systems are also included in the quality management system through monitoring.

This approach to quality management should be considered in more detail on the example of one of the largest US railway companies Norfolk Southern (NS). NS has implemented a Branded Transportation Service Plan, which aims to increase traffic while maintaining its quality. This plan is constantly being improved and extended, supplemented by several other important quality improvement tools. These tools include the Automated System for Coal Transportation Management, which is currently used to monitor not only coal, but also grain transportation, as well as the Automated Strategic Management System for Intermodal Transportation. Another program, the Unified Traffic Control System, was developed by the company in conjunction with the General Electric Corporation. It is a network of dispatcher workstations compatible with other information systems used on the Norfolk Southern railway. Currently, the System of Optimal Train Traffic Control is being prepared for testing. In addition, NS is implementing the LEADER locomotive computing system, the main task of which is to increase the efficiency of fuel consumption for train traction and improve the safety conditions for managing a train during its movement. Ultimately, it is planned to use the LEADER system as one of the subsystems of the OTC system. The Norfolk Southern Railroad has an automated traffic plan (OPA) system, including local traffic. The automated system for monitoring the implementation of the local transportation plan is interconnected with another automated system "Firm Station". There are several other automated control systems in this direction [14].

The formed information array gives an objective idea of the quality of service provided by the railway company to its customers. The accumulated information serves as the basis for a dialogue between the company and its customers on issues of further improvement of service quality. During the development and further improvement of data warehouses and the system for measuring the parameters of service quality, the task was to provide managers of the company "NS" with the possibility of prompt access to the information they are interested in. Daily and weekly reporting becomes the subject of discussion at meetings on operational issues. The problem of early detection of malfunctions and defects of the track and rolling stock is extremely important in terms of the quality of transport service, safety, and fuel economy. The company continues to make efforts aimed at timely detection of rolling stock malfunctions, for which floor sensors are widely used. The computer system for managing the car fleet receives data collected by devices that control the profile of wheels, the impact of the wheel on the rail, and other issues arising along the way [15].

As early as 1991, Norfolk Southern launched the Quality Excellence (TQM) program [15]. The program is aimed at maximum satisfaction of the needs and requests of the clientele, thus the improvement of service quality within the framework of this program should be ensured primarily by increasing the personal responsibility of employees and initiatives "from below". The key place in the program is occupied by two concepts: "flexibility" and "ingenuity". These qualities are necessary for success in a rapidly changing market environment. Thus, the full programmatic coverage of all activities of the Norfolk Southern company makes it possible to effectively manage the quality of work and, therefore, constantly increase the profitability of the company.

As an example, the quality management system of JSC "Ukrzaliznytsya" is the basis for organizing and improving technological and business processes. This system follows the requirements of the modern standard ISO 9001:2015 "Quality management systems. Requirements" [1] and includes: the policy reflected in the Regulation on the quality management system; the system of interrelated and complementary quality management processes; regulatory framework, which is a set of documents regulating the quality management system; an effective organizational mechanism, tools, and methods for implementing the requirements regulated by the company's regulatory framework.

The main directions of the Innovative Development Program of JSC "Ukrzaliznytsia" in the field of the Quality Management System are determined by the nature of the economic activity, considering the Development Strategy of JSC "Ukrzaliznytsia" until 2030 [16] and the

target Business model. The following areas of the Quality Management System in the service sector can be determined [7]: freight transportation ("Transport and logistics" business block); passenger transportation (business block "Passenger transportation"); quality of internal technological processes (business block "Railway transportation and infrastructure"); Quality management of product supplies for the needs of JSC "Ukrzaliznytsia"; certification of manufacturers of railway products for compliance with the requirements of IRIS (International Railway Industry Standard).

The content of measures for accounting and assessing the quality of transport services in the field of freight traffic in JSC "Ukrzaliznytsia" should be considered in more detail. The services of the "transport and logistics" business block are aimed at the qualitative achievement of key performance indicators for the innovative development of JSC "Ukrzaliznytsya", namely, the level of customer satisfaction, fulfillment of quality standards in the field of transport and logistics services, the share of contracts in the field of transport and logistics services for which reasonable claims were made (excluding force majeure), the total number of contracts in the field of transport and logistics services, specific number of traffic accidents and other events related to violation of train traffic safety.

The main criteria are the cost, the complexity of the services provided, their availability, information content about their composition and characteristics, the reliability of transport services, which in turn is determined by the timeliness of the consignment delivery, its safety, as well as the risk level of the consignor fulfilling contractual obligations of the carrier. The quality of transport services is influenced by the reputation of JSC "Ukrzaliznytsia" as a nationwide carrier of goods, ensuring the delivery of goods to any destination, including considering compatibility with other modes of transport in intermodal transportation [16]. Transport product quality management can be viewed as a comprehensive and coordinated assessment of the quality indicators of the transportation process and decision-making on the best (optimal) transport service for users based on existing quality standards for transport services and rail transport resources, considering the effective demand of the clientele. At the same time, it seems appropriate to expand the list of criteria for quality indicators that characterize the activities of transport companies from the standpoint of a systematic approach, as shown in Figure 1.

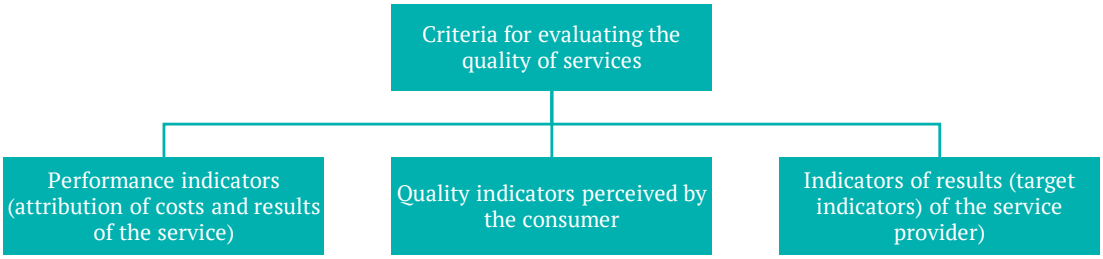

Figure 1. Criteria for indicators of transport product quality

Source: developed by the author

The whole variety of indicators (measurements) of the quality of transport products is proposed to be divided into three groups: the quality of technical means in transport; the quality of operational work of transport; quality of transport service for transport users.

The first two groups of indicators are focused on the third (main) group of final consumer assessments or indicators of the quality of transport service for users: the first two groups of indicators characterize the production quality of the internal processes for the implementation of the transport service, and the third – consumer quality of the transport service. The quality of transport services includes the entire range of transport services (cargo operations, registration of transportation documents, security and escort of cargo, additional information services, etc.), including the transportation process itself, movement of cargo [5]. At the same time, the cost (price) of transportation is an independent assessment indicator that is not included in the system of quality indicators but is an essential element in determining the competitiveness of transport products. Based on ongoing marketing research, transport companies can observe and analyse the dynamics of changes in the overall level of quality of transport services for cargo owners (Fig. 2).

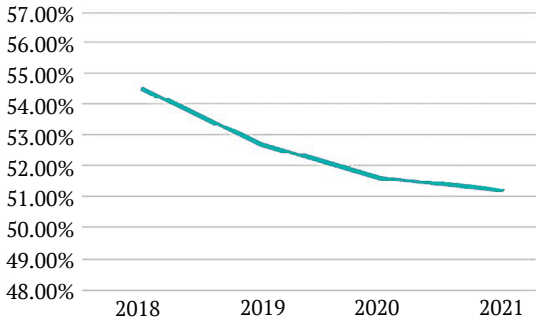

Figure 2. Dynamics of the average annual values of the service quality index of JSC "Ukrzaliznytsia" for the period from 2018 to 2021

Source: developed by the author

According to the presented dynamics, the value of the quality index, summarizing consumers' evaluation of the level of service quality in the market of cargo transportation by mainline railway transport, changed ambiguously [19]: there has been a significant decrease in the overall level of quality (from 57 points in 2018 to 51 points in 2015), which is due to the "low base" effect (liquidation

of the inventory fleet of cars of JSC "Ukrzaliznytsya" and transfer of services for the provision of cars for transportation to operating companies).

Thus, it seems appropriate to refine the system of quality indicators to provide a systematic assessment of customer satisfaction in relation to the parameters of the operated technical means and implemented technological processes. In the future, JSC "Ukrzaliznytsya" also sees itself as a leader in the European transport and logistics market by providing high-quality and economically attractive services [19]. Therefore, the main growth factors that will allow the implementation of the strategy are as follows: increasing the attractiveness of freight and passenger transportation by rail transport in Ukraine; increasing presence in markets outside of Ukraine due to increased cooperation and direct investments; building an effective logistics operator and increasing the share of logistics services in the company's overall portfolio.

The business model of JSC "Ukrzaliznytsya" involves improving the corporate governance system and introducing corporate social responsibility, increasing investment attractiveness for stakeholders, as well as introducing the basic principles of steel development, which is based on safety principles that lead to improved technology for managing the quality of railway transport services. An equally important indicator of the effectiveness of strategy implementation will be an increase in labor productivity per employee and a decrease in the level of depreciation of fixed assets (Table 1). The results of the implementation of JSC "Ukrzaliznytsya" development strategy will be beneficial for all transport market participants: shippers, passengers, and the state (Table 2).

Table 1. A plan to increase labor productivity and reduce the level of depreciation of fixed assets

Indicator	Years		
	2019	2020	2021
Labor productivity, thousand UAH (per employee)	337	394	459
Depreciation level of fixed assets, %:			
ruts	50	49	49
freight electric locomotives	87	81	79
the number of freight wagons exceeding the operation terms	29	27	25

Source: developed by the author

Table 2. Potential benefits from the implementation of the development strategy of JSC Ukrzaliznytsia in the period 2020-2021

Participants of the market of transport services	Potential benefit
cargo	Satisfying demand for transportation, namely providing more than 90% of applications;
senders	Speed of transportation and fulfillment of delivery terms. Improvement of wagon circulation by 20% and cargo delivery speed by 15%;
passengers	Quality of rolling stock (more than 30% of wagons and mainline locomotives have been updated).

Source: developed by the author

Summarizing this information, it can be concluded that, in general, JSC "Ukrzaliznytsya" has sufficient quantitative equipment with an operating locomotive fleet. But most of them, namely approximately 84%, have already served their useful life. This is due to the fact that the main number of locomotives was built in 1960-1990, and the level of renewal of rolling stock has recently been quite low. A large-scale renewal of the locomotive fleet is currently not possible primarily due to insufficient financial stability of Ukraine. For the same reason, foreign manufacturers of locomotives, which have been planning to open their production in Ukraine for a long time, are also unable to reach an agreement with JSC "Ukrzaliznytsya", because long-term agreements require stable financial support. In the context of the restructuring process at JSC "Ukrzaliznytsya", the company's management model emphasizes the importance of recognizing four key processes as the fundamental elements for delivering high-quality passenger rail transportation services. These processes encompass infrastructure, traction services, passenger transportation, as well as auxiliary functions related to production and services. Based on the mentioned above, it can be concluded that the technologies for managing the quality of rail transport services should be improved using modern methods of studying public demand for transport services and further improving consumer qualities of transport services to make a profit, increase the social significance of rail transport and obtain competitive advantages.

The quality of services is a complex and diverse concept. Being an abstract category, it is difficult to define and accurately assess it. Quality is defined as the ability of a product or service to best meet people's needs. Today, there are many ways to explain this concept and measure it. This is the result of a subjective approach to the assessment of

this phenomenon, as well as differences in criteria between producers and consumers. As a result, quality is defined as the conformity of the provided services with the expectations of customers or certain established standards. This is a complex concept that is constantly evolving and improving. In the light of global trends, the quality of railway transport must meet the needs and expectations of customers. Thus, the determination of the factors affecting the quality of service, as well as the basic standards that determine the quality characteristics of the services of the transport complex, are becoming more and more important. The system of service quality factors and criteria must be adaptive and flexible to meet changes in consumer demands and expectations and meet market requirements to ensure the industry's competitiveness in the European service market. This is due to rapid changes in the lives of modern consumers of transport services.

The analysis of research by R. Jancal [10], E. Vodovozov and O. Rudachenko [11], A. Bashan and S. Kordova [12] showed that the authors do not agree on the development of technology for managing the service quality of railway transport enterprises. Such algorithms can be the basis of a strategy for the development of innovations and investments in railway transport [20]. The author claims that this strategy will ensure the stability of the current state of railway transport enterprises and their ahead-of-the-line innovative and investment development. The study by M. Kuzhavsky [19] also considers railway transport as an important direction for the strategic development of the country. However service quality management is not fully considered. As a result, the peculiarity of this study is that the author's approach, which uses a conceptual scheme for determining the predictive values of service quality, based on economic and mathematical modeling, made it possible to predict the service quality management algorithm of railway transport enterprises and to develop measures aimed at improving this quality. M. Militaru [21] and S. Sahoo [22] investigated the relationship between quality management parameters and firm performance and identified the main obstacles to the implementation of quality management practices in production.

Investments in the industry are an important component of increasing the efficiency of quality management of railway transport enterprises. When diversifying the sources of investment of railway transport enterprises, priority should be given to Ukrainian investors in order to preserve national control and minimize the interference of foreign companies in the management of the sector. In this direction, the intervention and support of state authorities are critically important. In the future, this will contribute to the development of railway transport in Ukraine. There is no doubt that assessment and measurement occupy an important place in the issue of managing the service quality of railway transport enterprises. Transportation services, like many others, should be provided in the most cost-effective way. But now there are no sufficiently effective quantitative methods for objective assessment of the quality of some railway transport enterprises. In order to improve the efficiency of managing the service quality of enterprises in this industry, more attention should be paid to the problems related to ecology, as well as to the reduction of the harmful impact of railway transport on the environment.

The research has a practical aspect for the state, as it provides an opportunity to improve the quality management technologies of railway transport enterprises, to determine the projected investment volumes in the development of the country's regional development strategy, and to develop plans and recommendations for the development of railway transport enterprises. However, the improvement of railway companies' quality management technologies may lead to the problem of publishing data in official sources on time. Additionally, it should be remembered that the development of high-speed rail transport necessitates close coordination with the European Railway Agency, which oversees rail transport activity in Europe, to bridge the gap between Ukrainian railways and the technologically advanced railways of Europe on the path to Ukraine's integration into the European Union.

CONCLUSIONS

To guarantee the quality of railway transport, passengers must be the first priority for enterprises when developing a plan for assuring the quality of transportation and logistics services. That is, JSC "Ukrzaliznytsia" should first have a thorough understanding of passengers' needs before offering solutions to meet them. The recommended solutions are then assessed and contrasted in accordance with the degree of advantages in the next stage.

The provision of transportation services to passengers is based on a variety of business processes related to both the direct transportation of passengers and the process of ensuring the effective operation of the entire railway infrastructure. Four processes – infrastructure processes, traction service processes, passenger transportation processes, as well as auxiliary processes (production and service) – should be recognized as the foundation for high-quality passenger rail transportation services, according to the business model of company management developed during the restructuring process of JSC "Ukrzaliznytsia".

Transportation technology development, the coordination of actions of various departments in the railway transportation service, operational control of transportation quality, operational corrective, and preventive actions, as well as marketing, are all related to infrastructure processes. The construction of high-quality passenger services is connected to passenger transportation operations and is based on intelligent transport service systems.

The maintenance of the railway infrastructure, the technical conformity of the rolling stock to the transportation needs, and material and technical supply are examples of auxiliary processes. Taking into account everything mentioned above, the primary objectives of quality management include: systematically matching the level of transportation quality to the current and anticipated market needs, as well as exerting deliberate influence on growing needs; ensuring the competitiveness of railway transportation on the Ukrainian and international markets of transport services; defining objectives for enhancing the current transportation services and developing new types of related services; discouraging the use of unsafe or substandard services. The development of a methodical approach to assessing the level of service management of railway transport enterprises of Ukraine is the subject of further research.

REFERENCES

[1] Reijers, H.A. (2021). Business process management: The evolution of a discipline. *Computers in Industry*, 126, article number 103404. doi: 10.1016/j.compind.2021.103404.

[2] Othman, I., Norfarahhanim Mohd Ghani, S., & Woon Choon, S. (2020). The total quality management (TQM) journey of Malaysian building contractors. *Ain Shams Engineering Journal*, 11(3), 697-704. doi: 10.1016/j.asej.2019.11.002.

[3] Roldán, J.L., Leal-Rodríguez, A.L., & Leal, A.G. (2012). The influence of organisational culture on the total quality management programme performance. *European Research on Management and Business Economics*, 18(3), 183-189. doi: 10.1016/j.iedee.2012.05.005.

[4] Obruch, H. (2020). Formation of the conception of ensuring balanced development of the railway transport enterprises in the conditions of their digital transformation. *Business Inform*, 3, 119-127. doi: 10.32983/2222-4459-2020-3-119-127.

[5] Garayev, M. (2019). Investment potential of the enterprises of a railway transportation: The formation and development. *Economy and State*, 7, 96-99. doi: 10.32702/2306-6806.2019.7.96.

[6] Antosz, K., & Stadnicka, D. (2017). Lean philosophy implementation in SMEs – study results. *Procedia Engineering*, 182, 25-32. doi: 10.1016/j.proeng.2017.03.107.

[7] Nedeliaková, E., Štefancová, V., & Kudláč, Š. (2017). Six sigma and dynamic models application as an important quality management tool in railway companies. *Procedia Engineering*, 187, 242-248. doi: 10.1016/j.proeng.2017.04.371.

[8] Nedeliaková, E., & Panák, M. (2015). New trends in process-oriented quality management. *Procedia Economics and Finance*, 34, 172-179. doi: 10.1016/S2212-5671(15)01616-0.

[9] Stravinskiene, I., & Serafinas, D. (2020). The link between business process management and quality management. *Journal of Risk Financial Management*, 13(10), article number 225. doi: 10.3390/jrfm13100225.

[10] Jankal, R. (2014). Software support of quality management in the service sector. *Procedia – Social and Behavioral Sciences*, 149, 443-448. doi: 10.1016/j.sbspro.2014.08.285.

[11] Vodovozov, E., & Rudachenko, O. (2021). Devising a procedure for ensuring entrepreneurship protectionism in the context of financial capital investments for the purpose of rehabilitation of the transport sector. *Eastern-European Journal of Enterprise Technologies*, 4(13(112)), 34-41. doi: 10.15587/1729-4061.2021.238414.

[12] Bashan, A., & Kordova, S. (2021). Globalization, quality and systems thinking: Integrating global quality management and a systems view. *Heliyon*, 7(2), article number e06161. doi: 10.1016/j.heliyon.2021.e06161.

[13] Goecks, L.S., Santos, A.A., & Korzenowski, A.L. (2020). Decision-making trends in quality management: A literature review about Industry 4.0. *Production*, 30, article number e20190086. doi: 10.1590/0103-6513.20190086.

[14] Carvalho, A.V., Valle Enrique, D., Chouchene, A., & Charrua-Santos, F. (2021). Quality 4.0: An overview. *Procedia Computer Science*, 181, 341-346. doi: 10.1016/j.procs.2021.01.176.

[15] Theil, H., & Wage, S. (1964). Some observations on adaptive forecasting. *Management Science*, 10(2), 193-395. doi: 10.1287/mnsc.10.2.198.

[16] Development strategy of JSC "Ukrzaliznytsia" until 2030. (2017). Retrieved from http://surl.li/lrtkl.

[17] Petrenko, I. (Ed.). (2021). *Transport of Ukraine*. Kyiv: State Statistics Service of Ukraine.

[18] Winters, P.R. (1960). Forecasting sales by exponentially weighted moving averages. *Management Science*, 6(3), 224-342. doi: 10.1287/mnsc.6.3.324.

[19] Kuzhavsky, M. (2021). Strategy of innovative and investment development of railway transport enterprises. *Black Sea Economic Studies*, 72(1), 106-111. doi: 10.32843/bses.72-18.

[20] Gschösser, F., Cordes, T., Lumetzberger, D., Tautschnig, A., & Bergmeister, K. (2020). Railway transport systems' contribution to sustainable development. *IOP Conference Series: Earth and Environmental Science*, 588, article number 052024. doi: 10.1088/1755-1315/588/5/052024.

[21] Militaru, M., Ungureanu, G., & Chenic, A.Ş. (2013). The prospects of implementing the principles of total quality management (TQM) in education. *Procedia – Social and Behavioral Sciences*, 93, 1138-1141. doi: 10.1016/j.sbspro.2013.10.003.

[22] Sahoo, S., & Yadav, S. (2018). Total quality management in Indian manufacturing SMEs. *Procedia Manufacturing*, 21, 541-548. doi: 10.1016/j.promfg.2018.02.155.

Технології управління якістю послуг залізничного транспорту

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Анотація. Актуальність теми дослідження зумовлена кризовими явищами, котрі відбуваються у розвитку транспортної галузі України, які зумовлені як загостренням внутрішніх суперечностей у розвитку суб'єктів цієї сфери, так і впливом зовнішніх негативних факторів, пов'язаних з економічною та політичною кризою в країні. Метою роботи було визначення проблем управління якістю послуг, що надаються на залізничному транспорті. Визначено особливості сучасних транспортних послуг, порушено питання ефективної підготовки персоналу в умовах використання передових технологій навчання, надано характеристику надання послуг акціонерного товариства «Укрзалізниця». На основі економіко-математичних моделей доведено, що динаміка прибутку підприємств залізничного транспорту значною мірою залежить не лише від його техніко-технологічних можливостей, а й від соціально-економічних чинників щодо потреби та можливості використання технологій управління якістю послуг. Встановлено, що наявність вищевказаних розбіжностей і проблем суттєво впливає на рівень технології управління якістю послуг підприємств цієї галузі. Зроблено висновок про необхідність підвищення ефективності технології управління якістю послуг підприємств залізничного транспорту на основі використання сучасних підходів до всебічного вивчення запитів споживачів та подальшого підвищення споживчих якостей транспортних послуг з метою формування прибутку, підвищення соціальної значущості залізничного транспорту та отримання конкурентних переваг у майбутньому. Результати дослідження можуть бути використані для розробки державної стратегії регіонального розвитку, а також окремо для розробки планів і рекомендацій щодо розвитку підприємств залізничного транспорту на різних рівнях управління

Ключові слова: підприємства, залізнична галузь, стандарт, прогнозування, менеджмент

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