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RISK LEVEL ASSESSMENT WHILE ORGANIZATIONAL-MANAGERIAL DECISION MAKING IN THE CONDITION OF DYNAMIC EXTERNAL ENVIRONMENT

Purpose. Forming a complex factor of the project risk level assessment while organizational and economic decision making in a dynamic external environment based on measurement theory.

Methodology. The results are obtained through the application of the following methods: scientific generalization – for the formulation of scientific problems and general conclusions; measurement – to assess the project risk level; decision-making – to identify the problems of modeling the tasks of organizational and managerial decision making; modeling – during the elaboration of a risk level complex factor.

Findings. The risk uniformity factor is substantiated. It can be used to characterize an investment project in terms of the neighboring risk. This coefficient can be used as a correction one in the formation of a complete evaluation of risk package.

Originality. Provisions of quantitative risk assessment in the organization activity in the condition of the dynamic external environment are further developed. The difference from other approaches is the refusal of a priori assumptions about the stochasticity of studied processes and quantities. A distinctive feature of the proposed approach is also the sphere of the risk implementation: it is advantageous to use "risk" not in all situations with random outcomes, but only when this outcome does constitute a significant danger for the decision-making subject. The concept of a "substantial" or "fractional" amount has a convincing objective component, although it is generally subjective. We proceed from the risk concept as a subjective characteristic of the situation in conditions of uncertainty, reflecting possible damage to the subject making a decision.

Practical value. The developed methodological regulations considering risk factor influence, based on the offered approach to its quantitative estimation, will increase reliability level of accepted organizational-administrative decisions during the substantiation of project cost and time indicators in the conditions of the dynamic external environment.

Keywords: *risk, organizational and management decision, dynamic environment, damage, measurement, reliability*

Introduction. Natural-technical geosystems in the mining industry are dynamic and have high uncertainty level, therefore the risk factor is an integral attribute of the underground space development, including the period of construction, reconstruction or operation of mining production [1].

The most important indicators of investment industry projects are cost and duration, which are closely related to the economic efficiency of their implementation.

Substantiation methods for the cost and duration of the investment project implementation are of great interest, particularly, during the contractual price forming, since taking into account the influence of the stochastic nature of the determining factors increases the reliability level of taken organizational and managerial decisions. However, data analysis [2, 3] shows that the actual values of cost and time indicators significantly differ from the planned ones. These deviations may be caused by: inadequate, often optimistic project evaluations regarding the project scope, work cost and project duration; usage of deterministic project models that do not take into account the possibility of numerous unforeseen changes in the investment process significantly affecting the final result; lack of an integrated examination of such important factors as cost and duration.

Thus, the problem of efficiency improvement of the production organization and management process by improving the reliability level of organizational and

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managerial decisions needs to be further researched, taking into account the influence of risk and uncertainty factors in the evaluation and justification of project time and cost indicators.

Analysis of the recent research and publications. Certainly, the approaches to the project risk assessment proposed by the researchers [1–3] can be useful in justifying and making organizational and managerial decisions, but an issue of finding a comprehensive indicator of project risk assessment using the measurement theory is still relevant. For business entities operating in conditions of dynamic external environment, the concept of risk measurement that is adequate to real conditions should not be based on the classical principles of statistical probability, supposing the possibility of repeating events under the same conditions an unlimited number of times. In this regard, to assess the risk level in organizations activities, including those while making organizational and management decisions in a dynamic environment, special measurement tools should be used, with special scales, indicators, and algorithms among them. At the same time, the field of application of such indicators as, for example, mathematical expectation becomes narrower, since in the dynamic environment dependencies adequately reflecting actual situation, rarely meet the simplest relations underlying the linear models. Moreover, not only the type of dependence becomes unstable, but also a list of factors that have a determining influence on the studied process and are included in the model. Against this background, the field of application of expert evaluations methods is expanding. This especially refers to risk factors while making organizational and management decisions in a dynamic environment.

Objectives of the article. The purpose of the article is forming of a complex factor of the project risk level assessment while making organizational and economic decisions in a dynamic external environment based on measurement theory.

Presentation of the main research. Approaches to the quantitative assessment of risk in the activities of organizations, taking into account dynamical external environment, are oriented toward the economic activity sphere and differ from the approaches used in decision theory and operations research theory in which risk is associated with a stochastic situation when outcome of each alternative variant corresponds to a known probability of its appearance [4].

If we are speaking of organizational and managerial decisions taken by business entities as for resource investment, then the repetition of experience for the same subject under the same conditions, as a rule, is almost impossible. Thus, investing a certain amount in the project, an investor thereby changes the financial state and the repetition of experience will occur in different financial conditions. In this way, the concept of mathematical expectation of a random variable as a mean in the set of experiments does not have an obvious interpretation in such a situation. Similarly, in the sphere of making organizational and managerial decisions, other probabilistic characteristics lose clarity of interpretation.

In this way, it is possible to distinguish the first difference of the proposed approach from the classical one, which consists in rejection of a priori assumptions about the stochasticity of the studied processes.

The second difference is related to the sphere of the risk: the term “risk” is appropriate to use only when the outcome predetermines a significant danger to the business entity. Based on the risk essence as a subjective characteristic of the situation in a dynamic environment, reflecting the general possible damage to the business entity, the subjects of study are:

- the situation in which one or another decision can be made;
- uncertainty in the occurrence of one or another outcome of each of alternatives;
- the entity that makes decisions in terms of their consequences;
- consequence assessment of making decisions, taking into account their desirability or undesirability for the business entity.

Furthermore, the considered approach to risk level assessment is based on the measurement theory [5], according to which the solution of the problem of measuring one or another aspect of a particular situation involves realization of the following stages:

- system analysis and construction of subject area relational model (risk situation in the organization’s activities);
- scale selection for risk level assessment, taking into account the objectives of such measurement and the possibility of obtaining all necessary information;
- choice of a way of defining risk level measurement parameters, meeting conditions of scale homomorphism.

In this case, the subject area is understood as part of the surrounding world, which will be researched in the context of the measurement task, whilst the relational model is the representation of the studied subject area in the form of a set M on which the relation set is given, i. e. in the form [5]

$$S = \langle M; R_1, \dots, R_n \rangle,$$

where M is the set; $R_i \subseteq M_{k(i)}$ is the relation of degree $k(i)$, i. e. a subset of the Cartesian product k of elements of the set M, $i = 1, \dots, n$.

As a scale $Ш$, a relational system is understood [5]

$$Ш = \langle X; Q_1, \dots, Q_n \rangle,$$

where X is the set of values of the measurement index; $Q_i \subseteq X_{k(i)}$ is the ratio of the $k(i)$ degree on the set X.

The purpose of the scale is that its carrier X serves as the set of values of the metric measuring this property, and the relations on the numeric set X determine the relationships between the values of the indicator X.

As a measurer a mapping is understood [5]

$$f : M \to X,$$

which meets conditions

$$(m_1, \dots, m_{k(i)}) \in R_i \Rightarrow (f(m_1), \dots, f(m_{k(i)})) \in Q_i,$$
$$i = 1, \dots, n.$$

That is, the mapping f must be a homomorphism from the empirical relational system S to the scale relational system $Ш$: each set of elements $m_1, ..., m_{k(i)}$ associated with this relation R_i [5], by using this indicator goes to a set of elements that are in the corresponding relation Q_i.

As the carrier of the system M, many possible events (outcomes) should be considered, their occurrence is possible when the decision is made – one of the alternatives which are of significant importance to the subject of risk is chosen. There are two groups of relations on the set of events M.

The first group consists of one relation (we denote it by R_j), which characterizes an absolute or relative degree of reality (probability) of the occurrence of an event. Depending on the volume and content of information available at the time of analysis, this relation can be:

- binary: it is supposed that $(m_1, m_2) \in R_1$ if the occurrence of an event m_1 is more likely than m_2 $((m_1, m_2) \in M)$;
- ternary: $(m_1, m_2, m_3) \in R_1$ if the probability of occurrence m_1, in comparison with the probability of occurrence m_2, is higher than the probability of occurrence m_3, in comparison with the probability of occurrence m_2 $((m_1, m_2, m_3) \in M)$;
- quadruple: $(m_1, m_2, m_3, m_4) \in R_1$ if the occurrence m_1 in comparison with m_2 is higher than the probability of an occurrence m_3 compared to m_4 $((m_1, m_2, m_3, m_4) \in M)$, etc.

The second group consists of relations comparing events on the socio-economic damage that may be caused to the subject. This relation R_2, depending on the volume and content of available information, can also be: binary, ternary, quadruple, and others.

It should be noted that both R_1 and R_2 by themselves in practice are not determined uniquely, and their clarification depends on many factors, in particular, on the size of the funds allocated for the analysis of the risk situation.

The proposed approach to the choice of the scale and the algorithm for risk assessment is based on the preliminary solution of matters about measuring the probabilistic and socio-economic assessment of the situation since in this way the situation in the practical activity of decision making is analyzed. It should be started by choosing a scale for measuring probabilities. This choice is determined depending on two factors: objectives of measurement and the volume of available information about the studied situation. The goals related to the internal analysis of the situation, the difference in risk variants for different combinations of events can be achieved with relatively low-information variant scale, such as nominal and ordinal variants. Such a variant, as a rule, is not sufficient for practical tasks of making decisions, and, therefore, it is necessary to have tools to compare different outcomes in their probability. In this case, the scale should be at least orderly. In this situation, the set of values is a partially ordered set, which allows determining which of the outcomes is more probable, but does not allow determining to which extent.

The next in increasing order of informativeness is ratio scale. If there is enough information available, a scale that allows determining the relative probability of occurrence of each event from a given pair is constructed. Here X is a numerical set, whose elements are perceived not as absolute numbers, but as relative ones. During the freeze at one of the event, i. e. fixation of the unit of measurement, the scale becomes absolute.

Finally, if a fully "transportable" probability estimate is required, i. e. an estimate admitting comparison with the probability of events in a completely different situation, an absolute scale should be used in which each event has a single-valued numerical estimate of the probability of its realization. Such probability can be formed either on the basis of statistics (statistical probability) or on the basis of expert data (subjective probability). In all such cases, the set X is an interval [0, 1].

In our opinion, in order to develop "transportable" risk assessment, it is advisable to measure damage not in monetary units but in relative ones, which take values from the interval [0, 1]. To this end, it is appropriate to determine the financial harm as a percent of the total available assets.

To construct a risk assessment function, it is necessary to rely on a joint measurement of its two components, namely: the probability of occurrence and the level of expected losses (damage) [6].

Let us denote the probability (subjective or statistical) of occurrence of an unfavorable outcome as v and the amount of damage for the business entity that corresponds to this outcome as z_1. We will consider that this damage is of material nature and has monetary terms. If Z is the total amount of business entity investments, then the value $z = \frac{z_1}{Z}$ expresses its relative damage. The immediate task is to determine the risk assessment of an event on the basis of accounting values v and z.

Taking into account the fact that risk level assessment is subjective, the result also depends on the characteristics of the decision-making entity that determines its "psycho-type".

For perception and assessment of various aspects of a risk situation, the following characteristics of the subject matter: its attitude to risk; attitude to the loss of values; attitude to the acquisition of values.

In utility theory, the overall estimate of the outcome of (r) is determined by the product of the probability and the value of the utility

$$r = v \cdot z.$$

However, in general case, the possibility of interpreting probability as the limit of the frequency of occurrence of a certain outcome is very restricted due to the impossibility of carrying out a series of experiments with identical conditions. Thus, the product as a functional form of risk loses its exclusive position and becomes one of many possible types of risk function [6]. It should be noted that with an objective approach to the multiplicative function, some of its features are revealed, which can be hardly unconditionally accepted.

First of all, the function $r = v \cdot z$ is symmetric with respect to both variables. This means that their change has completely the same impact on the risk assessment. Meanwhile, different subjects have a different attitude to comparative evaluation of the "probabilistic" and "material" damage factors. For example, a "cautious" subject makes little difference between a large and small (but not zero) probability of loss, so for this subject, the impact of loss value on risk assessment is immeasurably higher than the effect of a change of probability. Consequently, for a "cautious" subject, the value of the partial derivative of the function $r(v, z)$ with respect to v is close to zero

$$\partial r/\partial v \approx 0.$$

At the same time, the "stingy" business entity does not accept the loss, so for it, the partial derivative of the function $r(v, z)$ with respect to z is close to zero.

The subject, which can be simultaneously referred to "stingy" and "cautious", is characterized by the condition $r(v, z) \approx \text{const}$.

The product of arguments as a functional form for risk assessment does not allow reflecting both the resulted and many other individual characteristics of the decision-making situation.

What alternative approaches can be proposed to the construction of single outcome risk function? Before answering this question, it is necessary to specify in which scale the risk will be measured. This question is related to two aspects: the target and the informational one. The targeting aspect determines what the risk is measured for. Here the following options are possible:

- the risk is assessed to receive additional characteristics of the alternatives in order to have a possibility to make more reasonable decision on the choice of one of them;
- the purpose of risk assessment is to evaluate variants of behavior in a broader context than this situation of decision-making, including a posteriori assessment of the consequences and outcomes;
- the purpose of the risk assessment is absolute and, as far as possible, objective risk assessment of certain outcome or alternative, allowing comparison of this indicator with alternatives evaluated by other subjects and appearing in other situations.

Thus, the target aspect of risk level assessment is determined by the degree of subjectivity and situational orientation of the evaluation.

In the first case, the target orientation places the smallest requirements to the informational character of risk level measurement scale, it may be even ordinal.

In the second and third cases, it is expedient to use the most informative scales of quantitative or absolute type.

Let us consider methods of risk function construction of an outcome $r(v, z)$.

Let us give the following case: $r(v, z)$ takes values on the ordinal scale. The task is:

- to obtain information about the ordering of a quite powerful discrete set of pairs (v_i, z_i), $i = 1, \dots, I$;
- using this information, to find a way to extend this relation of order to the entire set of pairs (v, z) in order to approximate the ordering of the pairs $(v_1, z_1), \dots, (v_n, z_n)$.

A very wide range of approaches to the solution of this problem is possible. Let us note some variants of the statement of the first part of the task:

- "test" points (v_i, z_j) are generated by the subject;
- "test" points are offered to the subject for evaluation by a certain technique.

The second case implicitly assumes that the subject is able to give a relative estimation (ordering) to any set of pairs (v_i, z_j). This corresponds to the approach of constructing a risk function as a computable function defined by the product of a segment [0, 1] and the set of all nonnegative real numbers.

The problem of developing a technique for forming a test sequence is not considered here.

Let us suppose that the test sequence $(v_1, z_1), \dots, (v_i, z_i)$ is set. To each pair, the subject gives a number that reflects the ordering of the pairs in terms of the undesirability of these outcomes.

Now the problem is limited to constructing of a binary relation on the set of all pairs (v, z) that approximates the best way an order given on a finite subset of pairs $(v_1, z_1), \dots, (v_n, z_n)$.

If to be based on the system of the revealed preference, i. e. given numbering of a finite set of values of the arguments (v_i, z_i), $i = 1, \dots, I$, then in order to implement the principle of adequacy of estimation (the invariance of the estimate with respect to monotone transformations of the original data), it is advisable to make an approximation based on first-order criteria [4]. These criteria provide both an approximation of the function values and approximation of its partial derivatives.

Choosing the criteria, it is necessary to take into account the fact that the marginal rate of argument replacement should be approximated to the greatest extent; to do this it is apparently necessary to use the ratio of the differences between the values of the following form $(m_i - m_j)/(m_k - m_j)$ as the initial data.

For this, it is proposed to solve the following problems: let us suppose that arbitrary values of probability v and size of losses z are given. We assume that probability of occurrence of a particular outcome increased by 0.1 and became equal to $v_1 = v + 0.1$. Is there such value of loss z_1 that degree of undesirability of new pair v_1, z_1 is the same as that of the previous one?

If the answer is negative, it has to be admitted that there is no substitutability between v and z (at least for given v and z), the risk function is of the form of

$$r = \varphi(\min(av, bz)) \text{ or } r = (\max(av, bz)),$$

where φ is a function of one variable; a, b are individual constants (parameters).

In the simplest case $\varphi = 1$.

With a positive answer, the following question is asked: by how many units should the magnitude of possible losses be reduced if the probability of this outcome increases by 0.1, so that the risk assessment of this outcome does not change?

After receiving the answer, the survey can be continued: does the indicated value depend on the initial values v and z?

A negative answer allows us to accept the hypothesis that the risk function is of the form of

$$r(v, z) = \varphi(av + bz),$$

where φ is an arbitrary function of one variable; a, b are constants (parameters), subjected to the specification (after normalization, one parameter can be left).

A positive response generates new survey cycle, the result of which is the construction of a table of expert estimates of the marginal rate of replacement. When this table is obtained, an approximation of the limit rate is constructed as well as a function of two variables for which the ratio of partial derivatives is equal to the constructed approximating function, if necessary.

If the values v and r are measured in absolute scale and take values from 0 to 1, then the described above procedure, strictly speaking, is not completely correct. To avoid this, instead of addition, we suggest using some other method for "small" change of the initial value of the variable and, accordingly, another way of measuring the change in function value.

Let us consider a numerical transformation $x \to x^*$, defined as follows

$$x^* = x + \delta_x - x \cdot \delta_x,$$

where $\delta_x = (x^* - x)/(1 - x)$ is the "small" value. This conversion preserves the definitional domain of the variable, since

$$x^* = x + \delta_x - x \cdot \delta_x = 1 - (1 - x)(1 - \delta_x),$$

then if $0 \le x \le 1$, $0 \le \delta_x \le 1$, as it is easy to see,

$$0 \le \max(x, \delta_x) \le x^* \le 1.$$

The transformation has the following interpretation: if $x \in [0, 1]$ expresses the probability of some event A, then x^* is the probability of an event $A + B$, where B is some event independent of A with a "small" probability of realization. Thus x^* is the result of a mental experiment on the expansion of the original field of events. If now $f(x)$ is some function where x is an argument, then its change should be considered as a reaction not just to increase in this argument (in economic studies usually is associated with the involvement of new resources in the process), but to the expansion of the space events affecting the values of the function.

Now let us suppose $f(x_1, \ldots, x_n)$ is some differentiable function taking values on an interval [0, 1]. Then the change of its values should be measured not using a difference $f - f^*$, where f^* is the new value of the function, but with the help of a value $\delta_f = (f^* - f)/(1 - f)$. In other words, just as in case of measurement of the argument change, instead of the usual addition, the operation $x + \delta_x - x \cdot \delta_x$ is used, here the new value of the function is represented in the form of $f^* = f + \delta_f - \delta_f \cdot f$. In this situation, it is natural to use value δ_f/δ_{xi} as a relative measure of the influence of the argument x_i on the function.

Within the limit $\delta_{xi} \to 0$ we obtain the following expression characterizing the effect of the i^{th} argument change on the function

$$\delta_f \big/ \delta_{xi} \to f_i^* = \partial(\ln(1 - f)) \big/ \partial(\ln(I - x_i)).$$

This characteristic is analogous to the standard partial derivative for functions taking values from 0 to 1, arguments of which are variables taking values in the same interval. It is precisely this characteristic that should be used in the process of testing risk subjects in constructing the single event individual risk assessment function $r(v, z)$. Thus, in constructing the risk function $r(v, z)$, the following characteristics are proposed to use as basic ones to raise subjective information

$$r \cdot v = \partial(\ln(1 - r))/\partial(\ln(1 - v));$$
$$r \cdot z = \partial(\ln(1 - r))/\partial(\ln(1 - z)).$$

So far, we have considered the construction of the outcome risk function, taking values on the ordinal scale. If the measurement is made in the ratio scale, then in the numbering of test pairs set, their order is reflected as well as the relative undesirability for decision-making subject. Thereafter, the evaluation result of the function $r(v, z)$ according to the criteria

$$Q_i = |r(v_i, z_i) - m_i| \to \min, \quad i = 1, \ldots, I$$

must be invariant in line with the multiplication of all m_i by an arbitrary constant. This is achieved, in particular, if the function $r(v, z)$ has a multiplicative estimated parameter.

It can also be recommended to include the approximation of relations m_i/m_j in the composition of criteria.

A similar approach is also used in case of a differential scale. Accordingly, if it is a matter of a quantitative (interval) scale, in the function $r(v, z)$ there should be two estimated parameters – multiplicative and additive free terms.

Now let digress into the study of ways to construct the risk function of the alternative, assuming that the risk functions of each outcome $r(v_j, z_j)$, $j = 1, \ldots, n$ are constructed.

A standard approach to the construction of general risk assessment of the alternative, that continues the standard approach to the construction of the risk function of an individual outcome as a product $r(v, z) = v \cdot z$, involves summarizing the risks of individual outcomes

$$p = r_1 + \ldots + r_n.$$

Such an approach is substantiated if each individual risk reflects an average amount of damage resulted from the j^{th} outcome for the whole series of experiments.

If the assumption of the possibility of the repeating experiment under the same conditions is rejected, the summation of the outcome risk functions to assess the alternatives risk loses its uniqueness and then only one of many options for aggregating function constructing $p - p(r_1, \ldots, r_n)$ is presented.

It is clear that the general risk assessment of the alternative must be of the same scale as the outcomes risks. The value $p(r_1, \ldots, r_n)$ can be considered as a statistic on a set of risk measurements of individual outcomes. It is known [5] that on an ordinal scale the sum is not an adequate ordering statistic. On the basis of A. I. Orlov's theorem on the median, it can be shown that in the ordinal scales the only assessment functions adequate with respect to monotone transformations are the terms of the variation series $r(1) \le r(2) \le \ldots \le r(n)$ composed of the values $r_i, \ldots, r_n$, i. e. such characteristics as maximum ($\max r_i$), minimum ($\min r_i$), median, lower quantile, and upper quantile. The choice of one of them is dictated by the decision-making situation conditions and, in particular, by the psychological state of the subject at the moment of making decision.

In the case of measuring in the scale of intervals (and in a similar case of measurement in the ratio scale), we are essentially within the framework of the classical situation, in the research theory, of decision-making with different outcomes represented by the matrix $E = (e_{ij})$ [4].

In general, in order to choose one of these options or to develop another criterion, it is necessary, in fact, to solve the problem of the analysis and assessment of the elasticity of losses replacement from the realization of individual outcomes in the aggregated alternative risk function. For this purpose, it is proposed to use a methodology similar to the methodology of choice of the production functions type.

In conclusion of the main points of the approach to the analysis and modeling of the risk level for a business entity, few remarks should be made:

- in this concept “losses”, “acquisitions” as a result of one or more different outcomes are not supposed to be summed. Starting from some limit values, losses can cause qualitative changes that are irreversible. This point of view results from the rejection of the a priori assumption about the repeatability of the decision-making situation;

- the risk functions of the alternative in this approach was constructed on the basis of aggregating the risk functions of individual outcomes;

- the risk functions of alternative and individual outcomes, as well as dependence of accuracy of these functions components on the resources spent on their determination, are the basis for constructing risk the optimization model system in the sphere of making organizational and managerial decisions.

In a number of cases, several independent subjects participate in the decision-making process. For each of them overall risk assessment can be formulated, making an assessment of the individual outcomes risks and alternatives in accordance with the stated in this paragraph provisions. However, the question of risk degree of the whole project appears. In the most general case, such an assessment is formed on the basis of the whole set of initial data on a specific investment situation: the composition of risk subjects; the composition of possible events for each subject associated with potential damage; probabilities of these events; the size of damage to the subject when they occur. However, it would be more natural to assume that the overall risk assessment of the project is formed not on the basis of primary information, but on the basis of already conducted risk assessments of specific subjects. In this case, the principle of hierarchical risk assessment is observed, the concordance of risk assessments by individual subjects (or their groups) and assessment complexity is achieved automatically.

Let us denote risk complex assessment of each project participant by r_i and an overall assessment of all project risks $r = (r_1, \ldots, r_n)$ by G. Then

$$G = f(r_1, \ldots, r_n),$$

where $r_1, \ldots, r_n$ are the risks of individual participants.

Variants of function selection f:

- $f = \max(r_1, \ldots, r_n)$, i.e. risk assessment of the project according to the risk of the riskiest participant;

- $f = \min(r_1, \ldots, r_n)$, i.e. risk assessment of the project according to the risk of the least risky participant;

- $f = 1/n \cdot (r_1 + \ldots + r_n)$, i.e. an average risk of all project participants;

- $f = (a_1, r_1^b + \ldots + a_n, r_n^b)^{1/b}$, i.e. a generalized expression for risk assessment that combines three previous expressions [1, 3, 4, 6].

A uniformity risk coefficient is an important factor characterizing project, taking into account a set of risk associated with that project [1, 3, 4, 6].

$$k = 1 - \min(r_1, \ldots, r_n)/\max(r_1, \ldots, r_n).$$

Conclusions. The uniformity coefficient, which takes values from 0 to 1, makes it possible to conclude whether the risk is evenly distributed among the project participants. If the value of k is close to zero, the risk is distributed evenly; the closer k is to 1, respectively, the higher the risk of the project is and more substantial the difference between the risks of individual project subjects is. This coefficient can be used as a correction in determining and justifying the most complete and reliable assessment of the risks set of a particular project.

Thus, an account of the risk factor influence on the basis of the proposed approach to its quantified assessment, in terms of the theory of measurements, will help to increase the level of reliability and validity of organizational and managerial decisions while justifying projects cost and time indicators in a dynamic external environment.

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Оцінка рівня ризику при прийнятті організаційно-управлінських рішень в умовах мінливого зовнішнього середовища

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Мета. Формування комплексного показника оцінки рівня ризику проекту при прийнятті організаційно-економічних рішень в умовах мінливого зовнішнього середовища на основі теорії вимірювань.

Методика. Результати одержані за рахунок застосування методів: наукового узагальнення – для формулювання наукових завдань і загальних висновків; вимірювань – для оцінки рівня ризику проекту; прийняття рішень – для виявлення проблем моделювання задач прийняття організаційно-управлінських рішень; моделювання – при розробці комплексного показника оцінки рівня ризику.

Результати. Обґрунтовано коефіцієнт рівномірності ризику, що може бути використаний для загальної характеристики інвестиційного проекту з точки зору пов’язаного з ним пакета ризиків. Цей коефіцієнт може використовуватися як поправочний при формуванні повної оцінки пакета ризиків даного проекту.

Наукова новизна. Одержали подальший розвиток положення кількісної оцінки ризику в діяльності організацій в умовах мінливого зовнішнього середовища. Відмінність запропонованого підходу полягає у відмові від апріорних припущень щодо стохастичності досліджуваних процесів і величин. Відмінною особливістю запропонованого підходу також є сфера застосування ризику: „ризик“ представляється доцільним використовувати не в усіх ситуаціях із випадковими наслідками, а лише тоді, коли даний результат дійсно представляє значну небезпеку для суб’єкта прийняття рішення. Поняття „значної“ або „незначної“ суми, хоча й містить вагомий об’єктивний компонент, у цілому має суб’єктивний характер. Ми виходимо з концепції ризику як суб’єктивної характеристики ситуації в умовах невизначеності, що відбиває сукупний можливий негативний вплив на суб’єкта, що приймає те чи інше рішення.

Практична значимість. Одержані методичні розробки з урахування впливу чинників ризику на основі запропонованого підходу до його кількісної оцінки сприятимуть підвищенню рівня надійності прийнятих організаційно-управлінських рішень при обґрунтуванні вартісних і часових показників проектів в умовах мінливого зовнішнього середовища.

Ключові слова: *ризик, організаційно-управлінське рішення, мінливе середовище, збиток, вимірювання, надійність*

Оценка уровня риска при принятии организационно-управленческих решений в условиях изменчивой внешней среды

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Цель. Формирование комплексного показателя оценки уровня риска проекта при принятии организационно-экономических решений в условиях изменчивой внешней среды на основе теории измерений.

Методика. Результаты получены за счет применения методов: научного обобщения – для формулирования научных задач и общих выводов; измерений – для оценки уровня риска проекта; принятия решений – для выявления проблем моделирования задач принятия организационно-управленческих решений; моделирования – при разработке комплексного показателя оценки уровня риска.

Результаты. Обоснован коэффициент равномерности риска, который может быть использован для общей характеристики инвестиционного проекта с точки зрения связанного с ним пакета рисков. Данный коэффициент может использоваться как поправочный при формировании полной оценки пакета рисков данного проекта.

Научная новизна. Получили дальнейшее развитие положения количественной оценки риска в деятельности организаций в условиях изменчивой внешней среды. Отличие предлагаемого подхода заключается в отказе от априорных предположений о стохастичности исследуемых процессов и величин. Отличительной особенностью предлагаемого подхода также является сфера применения риска: „риск“ представляется целесообразным использовать не во всех ситуациях со случайными исходами, а лишь тогда, когда данный исход действительно представляет значимую опасность для субъекта принятия решения. Понятие „значительной“ или „незначительной“ суммы, хотя и содержит весомый объективный компонент, в целом имеет субъективный характер. Мы исходим из концепции риска как субъективной характеристики ситуации в условиях неопределенности, отражающей совокупный возможный ущерб для субъекта, принимающего то или иное решение.

Практическая значимость. Полученные методические разработки по учету влияния факторов риска на основе предложенного подхода к его количественной оценке будут способствовать повышению уровня надежности принимаемых организационно-управленческих решений при обосновании стоимостных и временных показателей проектов в условиях изменчивой внешней среды.

Ключевые слова: *риск, организационно-управленческое решение, изменчивая среда, ущерб, измерение, надежность*

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