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# METHOD FOR ANALYZING AND ASSESSING THE RISK COST OF AN INNOVATIVE PROJECT

The subject matter of the study is the risks of an innovation project. The goal of the article is to develop a method for analyzing and assessing the risk of an innovative project based on specific risks taking into account the features of a particular project. The tasks to be solved included analyzing the peculiarities of risk management of an innovation project, determining a set of specific risks of the innovation project, developing a system of indicators for risk assessment, developing methods for qualitative assessment of the innovative project risk, developing a method for assessing the risk cost taking into account the features of the innovative project. The following methods were used: the system analysis, design approach, risk-oriented approach, heuristic methods for obtaining generalized indicators. The following results were obtained: the features of the innovation project risk were considered; two ways for accounting the generalized categories of the project risk were presented - relating to external and internal factors and in the context of risk assessment; the main stages of the risk management process were considered; the pattern for classifying specific risks of an innovative project was developed and factors for their assessment were specified; the elements of the pattern were presented in the form of tables indicating scores for probable values of each factor. The maximum score, by which the factors of each risk can be assessed, indicates its contribution to the integrated assessment, therefore, it can serve as a basis for determining relative weights. A type of non-linear relationship between a number of points and the probability of risk is given. The result of the project assessment involves assigning a risk group to it on the basis of the total innovation risk impact. To estimate the cost of a project risk, its innovation class should be determined according to a number of factors within the score scale. The cost of the integral risk of the innovation project is calculated taking into account its probability and the class of innovation. The developed method enables obtaining the integrated assessment of the risk of an innovative project based on expert scores within the score scale and taking into account the class of innovation in the project when assessing the cost of risk.

**Keywords**: innovative process, risk assessment, rating scale, risk cost, factors of specific risks.

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## МЕТОД АНАЛІЗУ ТА ОЦІНКИ ВАРТОСТІ РИЗИКУ ІННОВАЦІЙНОГО ПРОЕКТУ

Предметом дослідження в статті є ризики інноваційного проекту. Мета статті – розробка методу аналізу і оцінки ризику інноваційного проекту на основі часткових ризиків з урахуванням особливостей конкретного проекту. Завдання, які вирішуються: аналіз особливостей управління ризиками інноваційного проекту, визначення множини часткових ризиків інноваційного проекту, формування системи показників для оцінки ризику, розробка методики якісної оцінки ризику інноваційного проекту, розробка методики оцінки вартості ризику з урахуванням особливостей інноваційного проекту. Застосовані методи: системний аналіз, проектний підхід, ризик-орієнтований підхід, евристичні методи отримання узагальнених показників. Отримані результати: розглянуто особливості ризиків інноваційного проекту. Наведено два способи обліку узагальнених категорій ризиків проекту: з точки зору зовнішніх і внутрішніх факторів і з точки зору оцінки вартості ризику; розглянуто основні етапи процесу управління ризиками; сформована схема класифікації приватних ризиків інноваційного проекту з зазначенням факторів для їх оцінювання; елементи зазначеної схеми представлені у вигляді таблиць із зазначенням бальних оцінок для можливих значень по кожному фактору. Максимальна кількість балів, якою може бути оцінено фактори кожного ризику, говорить про його внесок в інтегровану оцінку, отже, може бути основою для визначення відносних ваг. Наведено вид нелінійної залежності між кількістю балів і ймовірністю ризику. Результат оцінки проекту - надання йому групи ризику на основі впливу сумарного інноваційного ризику. Для оцінки вартості ризику проекту запропоновано визначати його клас інноваційності по ряду факторів в бальній шкалі. Вартість інтегрального ризику інноваційного проекту обчислюється з урахуванням його ймовірності та класу інноваційності. Розроблений метод дозволяє отримувати інтегральну оцінку ризику інноваційного проекту на основі експертних оцінок за бальною шкалою і враховувати клас інноваційності проекту при оцінці вартості ризику.

**Ключові слова**: інноваційний проект, оцінка ризику, бальна шкала, вартість ризику, фактори часткових ризиків.

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## МЕТОД АНАЛИЗА И ОЦЕНКИ СТОИМОСТИ РИСКА ИННОВАЦИОННОГО ПРОЕКТА

Предметом исследования в статье являются риски инновационного проекта. Цель статьи – разработка метода анализа и оценки риска инновационного проекта на основе частных рисков с учетом особенностей конкретного проекта. Решаемые задачи: анализ особенностей управления рисками инновационного проекта, определение множества частных рисков инновационного проекта, формирование системы показателей для оценки риска, разработка методики качественной оценки риска инновационного проекта, разработка методики оценки стоимости риска с учетом особенностей инновационного проекта. Применяемые методы: системный анализ, проектный подход, риск-ориентированный подход, эвристические методы получения обобщенных показателей. Получены результаты: рассмотрены особенности рисков инновационного проекта; приведены два способа учета обобщенных категорий рисков проекта: с точки зрения внешних и внутренних факторов и с точки зрения оценки стоимости риска; рассмотрены основные этапы процесса управления рисками; сформирована схема классификации частных рисков инновационного проекта с указанием факторов для их оценивания; элементы указанной схемы представлены в виде таблиц с указанием балльных оценок для возможных значений по каждому фактору. Максимальное количество баллов, которым может быть оценены факторы каждого риска, говорит о его вкладе в интегрированную оценку, следовательно, может бать основой для определения относительных весов. Приведен вид нелинейной зависимости между количеством баллов и вероятностью риска. Результат оценки проекта - присвоение ему группы риска на основе влияния суммарного инновационного риска. Для оценки стоимости риска проекта предложено определять его класс инновационности по ряду факторов в балльной шкале. Стоимость интегрального риска инновационного проекта вычисляется с учетом его вероятности и класса инновационности. Разработанный метод позволяет получать интегральную оценку риска инновационного проекта на основе экспертных оценок в балльной шкале и учитывать класс инновационности проекта при оценке стоимости риска.

**Ключевые слова**: инновационный проект, оценка риска, балльная шкала, стоимость риска, факторы частных рисков.

**Introduction.** Activities aimed at the creation and implementation of innovations are always related to increased risks arising from uncertainty in predicting the efficiency of an innovative project. The lack of complete and reliable information leads to deviations between the planned and actual results of innovation processes. Therefore, while implementing the management of innovations, potential innovative risks should be taken into account.

## The analysis of recent studies and publications.

The existing scientific works on the development of the theory and practice of innovative project management focus on the theoretical and practical foundations of managing enterprise innovative activities [1, 2]. To make efficient decisions in the process of innovation development, the risk-oriented approach is used [3 - 5].

There is a conceptual approach to identifying the risks of innovative activities, which takes into account the peculiarities of the development of project-oriented scientific and technological organizations. Based on the results of risk assessment, companies with high, medium and low levels of innovative potential can be singled out [6].

An innovative risk is often defined as the probability of losses that can arise from investing funds in manufacturing new goods and services [7]. An innovative risk is believed to arise when introducing a cheaper production method compared to the existing one or when manufacturing goods using a new technology, which may lead to a lack of product demand [8]. There are various classifications of risks that an enterprise can face when implementing innovative projects [9 – 11]. When analyzing risks, their causes are considered [12, 13]. There are many methods for quantitative and qualitative assessment of innovative risks [14 – 17]. The combinations of methods for calculating and assessing types and amounts of risk are proposed, depending on the particular activity of an enterprise, types of innovations, needs for a specific innovation, the degree of novelty of a technology and product [17, 18].

But it is impossible to find a universal approach to take into account various risk categories of an innovative project. The fact that methods for analyzing and assessing innovative risks of projects are not perfect leads to errors in calculations and results in making wrong managerial decisions. The improvement of existing methods will enable assessing adequately and implementing innovative projects, which in general will contribute to the efficiency of innovative activities in the industrial sector.

**The goal of the article** is to develop a method for analyzing and assessing the risks of an innovative project. The following tasks are solved in the article:

- analyzing the features of risk management of an innovative project;
- identifying a set of specific risks of an innovation project;
- developing a system of indicators for risk assessment;

- developing methods for the qualitative assessment of the innovative project risk;
- developing methods for assessing the cost of risk, taking into account the features of an innovative project.

## The presentation of the basic material.

Let us consider the peculiarities of managing the risks of an innovative project.

The term "risk" refers to the probability of a negative or unfavorable event. In this case, a negative event does not involve achieving the desired result of an innovative process. The main task of managing project risks is to minimize losses related to problems that can arise.

The peculiarities of the risks of an innovative project are as follows:

- a risk includes a number of elements that are specific only for a particular innovative project and elements that are characteristic for traditional business projects;
- due to the objective uncertainty of the innovative project environment, there can never exist a risk-free situation;
- risk management includes alternative decisions;
- a risk is characterized by the facts that objective information can be incomplete, by an inadequate subjective understanding of risk can be inadequate and decisions made on risk management can be wrong;
- due to the uniqueness of an innovative project, a risk is caused by the uncertainty of further development of events as well as by the lack of adequate statistics relating all the project parameters;
- risk is characterized by monotonous dependence between the risk level and the level of the innovative project novelty;
- risk changes its features over time.

Let us consider the major factors that can cause risks. Risks in the innovation sphere depend on fundamental, market and internal factors. The fundamental risk factors are determined by the eco-political and political aspects of the functioning of the world community and Ukraine. Market risks are related to the dynamics of the market situation. Internal risk factors are determined by the peculiarities of the organizational structure and capabilities of an enterprise.

Other criteria for determining risk categories are their grouping into internal and external ones according to the impact factors. Therefore, a set of risks can be formalized as a combination of two subsets:

$$Risk = R^{In} \cup R^{Ex},$$

where $R^{In}$ is risks caused by the elements of the internal environment of a project implementation, which determine the level and capabilities of an enterprise and can be regulated by the project management team;

$R^{Ex}$ is risks of the external environment whose effect cannot be regulated. The external environment includes such elements as customers, competitors, governmental establishments, suppliers, financial organizations, labor sources, co-performers.

Let us consider two generalized risk categories. $P_i$ designates the probability of a technical risk and $P_c$ is the probability of a commercial risk. If these risk groups are assumed to be independent, the total project risk can be expressed as $P_iP_c$. Then, the cost of risk can be estimated considering the expected value of the "effect-cost" ratio, using the formula:

$$E^R = \frac{B}{C}P_iP_c \;,$$

where $B$ is an effect or result; $C$ is expenses.

The goal of the risk management of an innovation project is to prevent or reduce potential losses, which implies the use of various management methods. The risk management process involves a series of steps.

Probable risks can be identified and grouped by the categories.

Risk assessment and analysis include:
- assessing risk probability;
- assessing the amount of losses – probable disbenefit.

Basing on the analysis of the information received, taking into account risk factors, the management strategy can be selected, that is measures to counter and eliminate the risk consequences.

The qualitative risk assessment is the first stage of its analysis. The resulting assessment can be used when ranking project risks when there is a preliminary assessment of the risk probability and consequences.

The methods of qualitative risk assessment are based on specifying the major indicators and their expert assessing.

The system of indicators to assess the risk of an innovative project is as follows.

The analysis of variants for implementing an innovative project should lead to selecting the most preferred variant according to the profitability and risk criteria. To do this, the following qualitative factors of assessment are used but using a quantitative scale.

An innovative project is assessed by a number of specific risks (Fig. 1):
- technological,
- informational,
- operational,
- personnel,
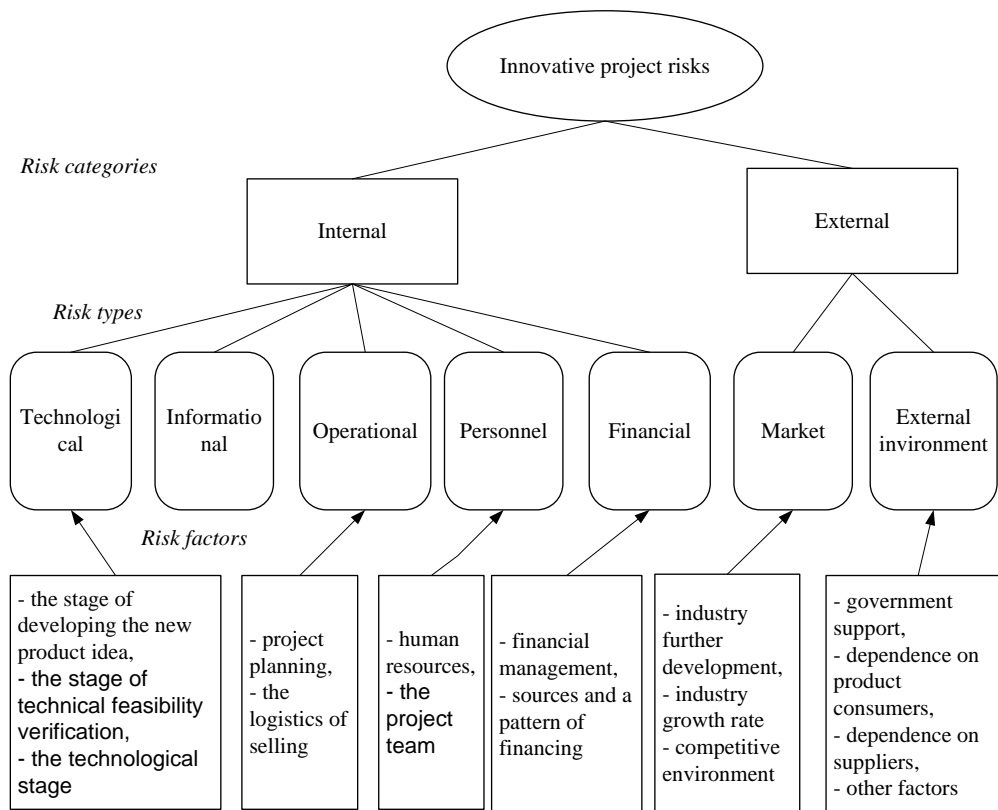- financial and economic,
- market,
- external environment.



Fig. 1. The types of specific risks and factors for their assessment

The first five specific risks refer to the category of internal risks, the other two – to the category of external ones.

Risk assessment indicators are grouped by corresponding factors (it should be noted that only one indicator is used for the informational risk).

There is a direct relationship among the information support of the project, its technological stage and the magnitude of the innovation risk. There is little probability that information relating to the properties and indicators of the final product and its technical parameters will be available. The lack of information increases the innovative project risks. At further levels of project planning, the

information support becomes more qualitative and detailed, which results in a decrease of risks.

Table 1 shows a list of indicators and score that can be used to conduct an expert assessment of the technological factors of the innovative risk.

Table 1 – The indicators for assessing the technological risk factors

| Project indicators | Score |
|---|---|
| 1. The stage of developing the new product idea | |
| The project is at the stage of the scientific validity of the idea. | 0 |
| The project has significant design drawbacks, defects or errors that significantly affect the implementation of the project. | 0 |
| The project has a scientifically based idea of fundamentally new developments, technologies and equipment. | 1 |
| 2. The stage of technical feasibility verification | |
| The project involves the financing of research and development. | 0 – 2 |
| Reference letters of state or local authorities are attached to the project. | 1 – 3 |
| The project is supported by the authorities. | 2 – 5 |
| The project is an integral part of targeted state or local investment programs. | 4 – 5 |
| Part of the project funds is purposely financed by budget funds. | 4 – 5 |
| 3. The technological stage | |
| The project requires that production should be upgraded technologically, materials, processes and design be improved. | 2 – 3 |
| The project is at the end of the technological stage; further capital construction, installation and other technological measures are planned. | 3 – 5 |

Table 2 shows a list of indicators and score that can be used by experts to analyze the factors of the informational risk.

Table 2 – The indicators for assessing the factors of the informational risk

| Project indicators | Score |
|---|---|
| Project participants are not provided with necessary information or information is deliberately falsified. | 0 – 1 |
| All the necessary information is given but it is not enough for the efficient implementation of the project. | 0 – 2 |
| Project participants are provided with all requested information but do not have complete information. | 3 – 4 |
| All necessary information is given in full and on time. | 4 – 5 |

The assessment of the prospects for an innovative project should include the analysis of the competitive environment and be based on a comparison and analysis of the activities of various companies within the industry. Understanding the general principles of the impact of competitive forces on the position of the enterprise in the industry enables making an economic forecast of the project and, if necessary, revising the strategy of the enterprise. Table 3 shows a list of indicators and score that can be used for assessing market risk factors. The analysis of industry trends enables identifying and assessing risks typical for projects in a given industry and determining the forecasted stability of a project.

Indicators for assessing operational risk factors, personnel risk, external environment and financial risk are determined in the same way with the values from 0 to 1. It should be noted that some factors of external environment negatively affect the project implementation and are assessed by a negative value - 5.

Table 3 – The indicators for assessing market risk factors

| Project indicators | Score |
|---|---|
| 1. Industry expected future | |
| In the market, demand is significantly lower than supply, prices are falling | 0 – 1 |
| Supply roughly corresponds to demand | 2 – 3 |
| Potential market volume is several times higher than the volume of available production | 4 – 5 |
| 2. Industry growth rate | |
| Production decline | 0 – 1 |
| Stagnation with signs of recovery | 2 – 3 |
| Moderate stable positive dynamics | 4 |
| Positive annual growth above average in the economy | 5 |
| 3. Competitive environment | |
| The products of competitors have price and quality advantages over products whose manufacturing underlies the innovative project. | 0 – 1 |
| There are factors for tougher (than before) competition in the industry | 2 – 3 |
| Competition is low, the market is protected from competitive foreign products | 4 |
| There are no significant competitors in the market | 5 |

**Assessing the cost of risk of an innovative project.**

As the examples of the above tables show, each risk makes its (unequal) contribution to the overall risk assessment of an innovative project. The maximum number of score points, used to assess the factors of each risk, indicates its contribution to the integrated assessment, therefore, it can act as a basis for determining relative weights.

Given that the score points of the project score vary from -5 to 81, such coefficients of significance have been calculated for each risk (Table 4):

Table 4 – The scale of scoring specific risks and their relative coefficients of significance

| Specific risk | Score | Relative coefficient of significance |
|---|---|---|
| technological | 0 –11 | 0,128 |
| informational | 0 – 5 | 0,058 |
| operational | 0 – 10 | 0,116 |
| personnel | 0 – 10 | 0,116 |
| financial | 0 – 10 | 0,116 |
| market | 0 – 15 | 0,174 |
| external environment | -5 – 20 | 0,290 |

According to the results of the expert assessment, a number of points relating to the risk of the project are calculated and its corresponding probabilistic and linguistic estimates are determined (Table 5). Note that the

relationship between a number of score points and the level of risk is non-linear (Fig. 2).

The result of the rating is the assignment of a risk group to an innovative project on the basis of the impact of the total innovative risk.

To assess the project risk cost, its innovativeness class should be determined.

Table 5 – Assessing the integrated risk according to different scales

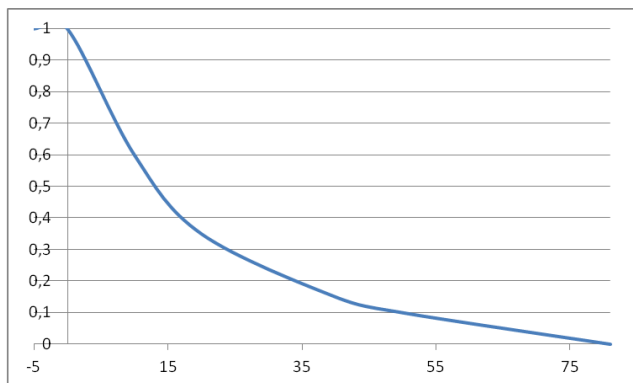| Integrated assessment of the project risk | | Qualitative assessment (linguistic scale) |
|---|---|---|
| Point scale | Risk probability (PRisk) | |
| <10 | [0,60 – 1] | Too high risk |
| [10 – 20) | [0,35 – 0,60) | Maximum risk tolerance |
| [20 – 40) | [0,15 – 0,35) | Acceptable Risk |
| [40 – 50] | [0,10 – 0,15) | Standard risk |
| >50 | <0,10 | Minor risk |



Fig.2. The form of dependence between the point scale and the probability

The project content is analyzed according to the following factors:
- the kind of innovation,
- the field of innovation implementation,
- the type of innovation,
- the project type,
- the level of the customer organization,
- the territorial scale of innovation,
- the scale of innovation spread,
- the degree of innovativeness,
- the depth of changes,
- the reason for innovation,
- the stage of the lifecycle of demand for a new product,
- the nature of the curve of the product lifecycle,
- stages of the product lifecycle,
- the level of technology variability,
- the stage of the technology lifecycle,
- the stage of the innovation lifecycle,
- the duration of the innovation project.

For each characteristic, an appropriate element is selected from the group of innovation processes. Each element has its own score from 1 to 8. Then the integrated assessment is calculated as the arithmetic average of all characteristics.

Depending on the class of the innovative project, "risk premium" is established, which characterizes the forecasted project budget growth (as a percentage of its value) (Table 6).

Then, the cost of the integrated risk of the innovative project is determined according to the following formula:

$$E^R = \frac{CP_{Risk}k_c}{100\%},$$

where $P_{Risk}$ is risk probability (Table 5), $k_c$ – is budget growth (Table 6).

Table 6 – Increasing the cost of the project, taking into account its innovativeness class

| Innovativeness class | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Budget growth % ($k_c$) | 0,0 | 0,5 | 1,0 | 2,0 | 5,0 | 10 | 20 | 30 |

**Conclusions.** The analysis of the risk characteristics of an innovation project showed the need for its qualitative assessment, taking into account a significant number of heterogeneous factors. The uncertainty of innovation processes made experts use scores for assessing. The developed method considers seven types of specific risks, indicators and a scale are proposed for assessing. While assessing the cost of risk, the class of the project innovativeness is taken into account and the degree of possible increase in the project budget is determined.

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22

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