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MODELS OF MAKING DECISIONS TO SELECT THE TECHNIQUES FOR COUNTERING INNOVATIVE PROJECT RISKS

The **subject matter** of the study is the risks of an innovative project. The **goal** of the article is to develop models of making decisions to select the techniques for countering innovative project risks. The following **tasks** are solved in the article: the features of managing innovative project risk are analyzed, a generalized model of the project risk management is developed, the mechanisms to counter the innovative risks are analyzed, a decision tree is developed to select the technique to counter innovative project risks, a formalized method and a process model are developed to select a preferred technique for risk insurance. The following **methods** are applied – system analysis, project approach, risk-based approach, heuristic decision-making methods, process models. The following **results** are obtained: the analysis of the features of managing innovative project risks showed the possibility of reducing the cost of risk by modern techniques of countering financial risks, including insurance in its various forms. A generalized model of managing innovative project risks is proposed; this model includes the stages of developing possible measures to counter risks and making decisions on selecting the preferred option. The probable types of innovation project risks, methods of their assessment under uncertainty are considered. The techniques to counter innovation risks, including the types of project risk insurance, are analyzed. A decision tree is developed to select a technique for countering risk based on a number of its characteristics that are defined according to the qualitative and classification scale. The suggested technique is formalized for selecting a mechanism to insure project risks, taking into account the probabilities of specific risks, their costs and the general insurance fund of a project. A process model is developed to select the preferred technique of insurance, taking into account the integral assessment of an innovation risk. **Conclusions.** The use of the developed models while planning the risk management of an innovative project increases the validity and reliability of decisions concerning the selection of a technique for countering risks, taking into account the characteristics of specific risks, the magnitude of the integral risk and the features of a particular project.

Keywords: innovative project, risk probability, risk mitigation, risk countering techniques, risk insurance.

Introduction

The implementation of innovative projects is usually linked with the investment of money to long-term assets, which result in probable project risks. Analyzing and developing the techniques for countering innovation risks is a difficult task of project management. Decisions made in this area are designed for long periods of time and, as a rule:

- are a part of the strategy of the firm prospective development;
- cause significant outflows of funds;
- can become irreversible from a certain point in time;
- are based on projected assessments of further costs and revenues.

Therefore, a preliminary analysis is of particular importance; this analysis is carried out at the stage of development of an innovative project and contributes to making sound management decisions. In order to make a correct analysis of the efficiency of planned capital investments in innovations, many factors should be taken into account, the expected efficiency of the project should be assessed as well as the risks of cash flows and decisions that will reduce the loss of the project in case of emergency.

The analysis of recent studies and publications. The available works on the issues of managing risks of innovative projects deal with theoretical and practical grounds for qualitative and quantitative assessment of risks [1 - 3]. The innovative risk is often determined as the probability of losses that occur when an investor invests money in manufacturing new goods and services [4]. There are various classifications of risks a business can face while implementing innovative projects [5, 6].

While analyzing risks, their causes are considered [7]. The techniques for analyzing risks are developed; these techniques are the assessment of risks depending on the peculiarities of enterprise activities, the degree of the innovation novelty [8], the analysis of the innovation risk at separate stages of the project life cycle; and the scale of financial investments is suggested [9].

There are works dealing with theoretical and practical issues of the risk management where one of the important stages is the task of selecting a means of reducing risks [10, 11]. The sequence of risk management for venture financing has been determined and the ways for minimizing risks have been described. In particular, the principles of project construction and diversification have been emphasized [12–14]. The issues of minimizing risks are considered basing on the detalization of risk-forming factors taking into account the degree of uncertainty of the external environment [15, 16].

Foreign authors pay great attention to the development of standards to control credit, financial and operational risks [17–19].

However, little attention is paid to the issues of selecting techniques and mechanisms for countering risks. While making decisions on selecting a technique for reducing risk, the degree of risk itself is not taken into account. The peculiarities of innovation risk are not taken into account as well.

One of the most efficient ways to counter risks is insurance. This technique is used mainly for credit institutions or to manage the financial risks of a project

[20]. Insurance is considered as a system of economic relations between insurance organizations and project managers. The need for financial independence of the project and the interest of the manager in the delegation of responsibility for the consequences of risk to specialized organizations are emphasized [21].

The goal of the article is to develop models of making decisions on selecting the technique for countering innovative project risks. The tasks to be solved are:

- peculiarities of managing innovative project risks should be analyzed;
- a generalized model for managing project risks should be developed;
- mechanisms for countering innovation risks should be analyzed;
- a tree of decisions for selecting the technique for countering innovative project risks should be developed;
- a formalized method and a process model for the selection of the preferred technique of risk insurance should be developed.

Materials and methods of the study

The main task of managing innovation risks is to minimize the losses linked with the nonconformity that have arisen in the course of project implementation. The risk management process includes the following tasks:

- risk identification;
- risk analysis and assessment;
- the development of measures to reduce the impact of specified risk factors on innovative processes.

The main consequence of the risk is the overspend of time and money to achieve the goal by increasing a number of works and the duration of their fulfilment; besides there is the possibility that the specified requirements for the project results will not be achieved.

The generalized model of managing the risks of an innovative project (Fig. 1) is proposed; this model includes a number of stages:

1. Identification of probable risks, grouping risks into categories [21].

2. Risk assessment and analysis:
- assessment of the probability of risk realization,
- assessment of the value of losses - probable damage,
- qualitative risk assessment by comparing the obtained quantitative assessments with acceptable values.

The selection of the assessment technique dramatically depends on the volume and characters of the initial data about risk factors.
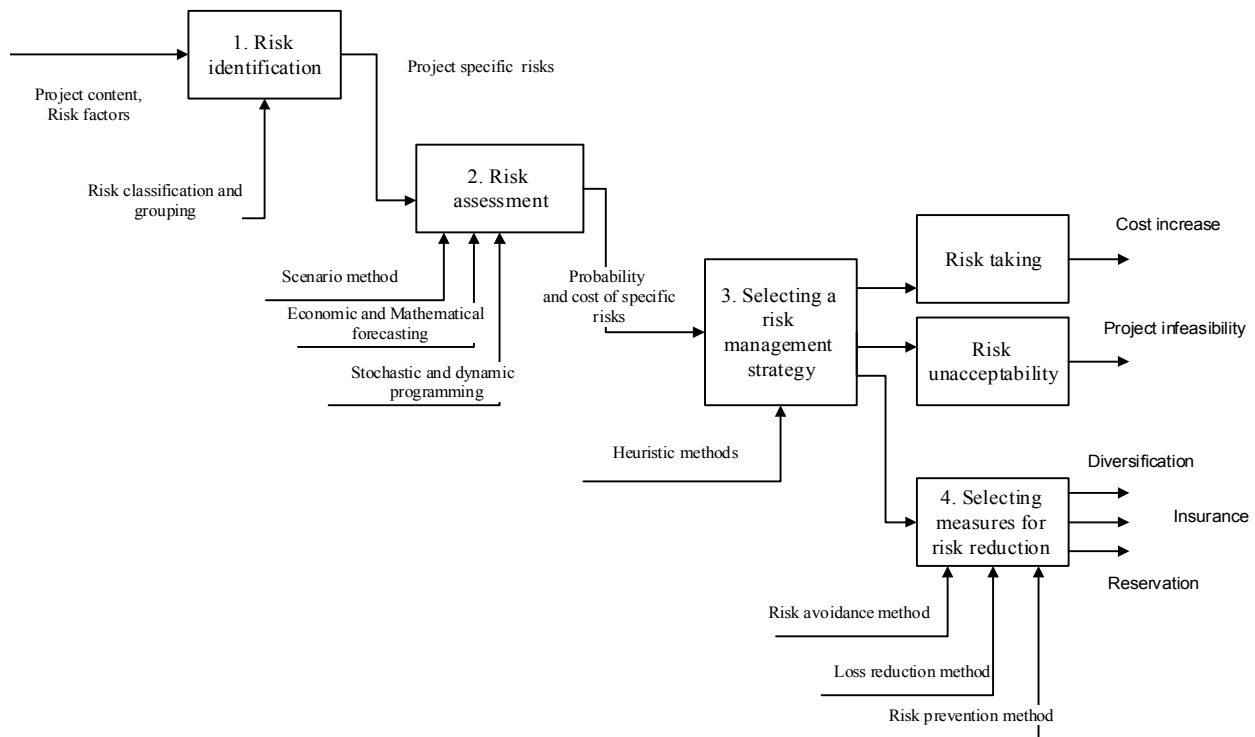

Fig. 1. The generalized model of managing innovative project risks

3. Basing on the analysis of the information received, taking into account the characteristics of risk factors, the important issue of analyzing an innovative project under uncertainty – the selection of risk management techniques and tools – is solved. The following basic risk management techniques are used in the theory and practice of project management: absorption – taking a risk by taking into consideration probable losses in general project costs; reducing risk by controlling, preventing, or insuring it; eliminating risk by recognizing its inadmissibility.

Risk avoidance actually means the refusal to implement an investment project or the project substantial transformation after which the project risk is practically eliminated. To decrease the risk degree, there are various techniques: risk avoidance technique; risk prevention technique; damage reduction technique. Risk avoidance is directed at the mitigation of risk that

involves developing intrinsic procedures which completely eliminate a specific type of risk. Risk prevention means that project activities are controlled in such a way that project participants can maximally affect risk factors and can decrease the probability of an emergency. Let us consider the features of these actions in relation to innovative projects. Thus, at the stage of identifying the risk of innovation, risks of innovation are most likely to happen if:

- the market rejects the innovation;
- there is no profit planned from the innovation introduction;
- the actual parameters of the innovation do not match the planned indicators;
- there are no results of innovation activities by the deadline specified in the project;
- patent rights are violated;
- the company 'know-how' is lost.

At the second stage of the selection of analysis and assessment techniques, the factors of uncertainty in making decisions on risk management should be taken into account. To assess the innovation risk, the following methods are efficient: scenario method to check project sustainability or sensitivity; methods of economic and mathematical forecasting (analysis of time series and regression-correlation analysis), methods of stochastic and dynamic programming with a formalized description of uncertainty.

Scenario method involves developing scenarios for project implementation under the most probable and the most unfavourable conditions for some participants. In the context of each scenario, it is investigated how the mechanism for making a decision will operate under appropriate conditions and what the amount of income and losses will be as well as the project performance indicators. The decision is considered sustainable if in all the situations considered, possible adverse effects are eliminated by the created reserves and reserves or they are recovered by insurance payments.

The risk of a project under the deviation of planned economic characteristics can be analyzed by calculating the sensitivity of key financial criteria of the project assessment to deviations of these characteristics. If there is a particular sensitivity to a certain parameter, more thorough analysis of trends in the change of such a parameter during the project is required.

The method of the formalized description of uncertainty is the most preferred but also the most difficult one in the context of its implementation. This method includes the following stages:

- describing the entire set of probable conditions for making the decision (as the system of restrictions on the values of the main resources of a project) and the costs, results, and performance indicators corresponding to these conditions;
- transforming the initial information about the factors of uncertainty into information about the individual probabilities of implementation and the corresponding performance indicators or about the intervals of their change;
- determining performance indicators of the decision as a whole taking into account the uncertainty

of conditions for its implementation - the indicators of expected efficiency [10].

At the third stage of risk management, the measures for risk countering (mitigating) should be selected. The system of internal and external mechanisms of minimizing financial risks involves using the following basic methods:

1. Diversification - is the distribution of capital among various investment objects that are not related to each other directly; this is the most reasonable and relatively less costly way to mitigate the degree of financial risk.

2. Reservation of funds (self-insurance) - its mechanism is based on keeping a part of the financial resources of the project in reserve, which enables overcoming the negative financial consequences.

3. Risk insurance is a method that enables reducing the damage arising while implementing the project due to financial compensation for losses from special insurance funds.

Results

Selecting a technique for countering a risk including the type of insurance generally depends on the risk probability (P), its cost (the amount of damage) (X) (Fig. 2) and the way of its behaviour (S).
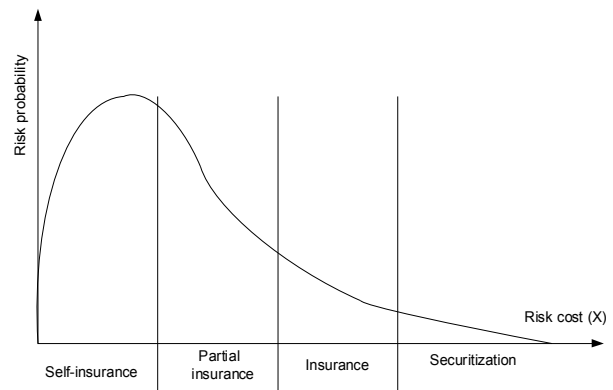

Fig. 2. Recommended techniques of project insurance depending on the probability of risk and risk cost

Thus, a risk can be characterized by a set of parameters: $R = <P, X, S>$. The following values of the above parameters are considered: $P \rightarrow$ max/min is the significant or little probability of the risk; $X \rightarrow$ max/min is the significant or little losses from the risk; $S \in \{E, M\}$, where E means a single risk, M – a mass one.

Depending on the variant of the combination of risk parameter values (taking into consideration the areas singled out in Fig. 2), the decision tree for selecting the way of its countering (Fig. 3).

While managing project risks, a way of insurance should be selected. Risk insurance can be rejected or accepted partially (co-insurance) or entirely for reinsuring. Self-insurance is applied for big projects to prevent the loss of large financial resources, in addition, the amount of amount of contributions to the reserve fund is lower than the level of commercial contributions. The mechanism of self-insurance lies in the fact that the reserve fund (designated as SF) is

formed for the project; this fund that is greater or equal to the value of probable damage
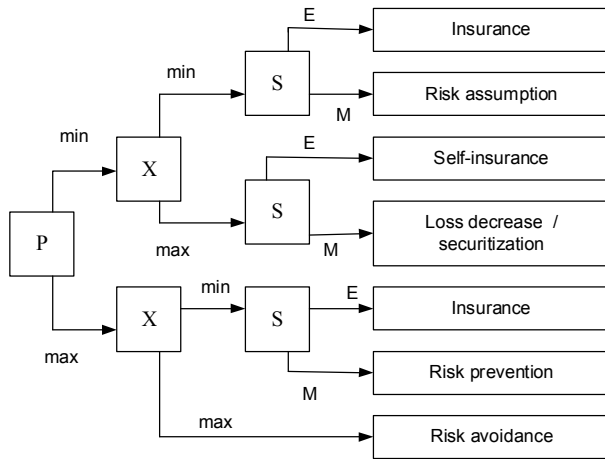

Fig. 3. The tree of decisions
on the selection of the technique to counter a risk

Let J risks be identified in the project, p_j is designated as the probability of the jth risk. In the case of risk realization, the damage of the project can be equal to ΔX_j. If the project manager wants to ensure the obligatory implementation of the project, the reserve should be formed that is equal to $SF = \max\{\Delta X_j\}$. The amount of the insurance fee for each risk will be determined $l_j(\Delta X) = p_j \Delta X_j$. In a general case

$$\forall j : \sum_{j=1}^{J} l_j(\Delta X) = SF . \text{ However } \exists j : \Delta X_j > \sum_{j}^{J} l_j(\Delta X)$$

that is, the sum of all risks insurances can be insufficient to compensate for the probable losses.

To select the mechanism of insurance, the following technique is proposed:

1) if $\sum_{j=1}^{J} \Delta X_j \leq SF$ and $p_j \to \min$, the mechanism

of insurance can be applied. Probable losses can be compensated form the reserve fund;

2) if $\sum_{j=1}^{J} \Delta X_j \leq SF$ and $p_{\min} < p_j < p_{\max}$ (the

risk probability is mean) or $\exists \Delta X_j < SF$ и $p_j \to \min$, the mechanism of mutual insurance can be applied. The amount of losses and risks will be redistributed among the project performers;

3) if $\sum_{j=1}^{J} \Delta X_j > SF$ and $p_{\min} < p_j < p_{\max}$, the

mechanism of commercial insurance should be applied;

4) if $\sum_{j=1}^{J} \Delta X_j > SF$ and $p_j \to \max$, such risks

should be rejected. In this case, the project will be considered as a high-risk one and it will be very difficult to insure it.

In case, when the integral risk of an innovative project is assessed on the basis of specific risks and many factors are taken into account, a procedure for selecting the type of insurance is suggested, which involves the following stages:

1) determining the project stages, where risk factors can happen;

2) scoring risk factors in groups (technological, informational, operational, personnel and so on);

3) calculating the integral score of innovation risk;

4) in case if the risk is within the acceptable value for the given project, assessing the class of the project innovativeness;

5) calculating the risk "premium";

6) taking into consideration the cost of risk and "premium" in terms of the profitability of the project,

7) selecting the type of insurance considering the value of the innovation risk.

At the final stage, the preferable insurance is determined by the following rules:

– if the integral assessment of the innovation risk is $R < 0,05$, self-insurance is recommended,

– if $0,05 \leq R < 0,4$ – mutual insurance,

– if $0,4 \leq R < 0,8$ – commercial insurance,

– if $R \geq 0,8$ – the project is considered as a high-risk one, insurance is not recommended.

The process model that reflects the stages, the transmitted information and the methods used to select the method of insurance is given in Fig. 4. This model is a variant of stage 4 decomposition (selection of measures for risk reduction) of generalized risk management in case if the project insurance is selected as the risk management method.

Conclusions

The above analysis of the peculiarities of managing the innovative project risks shows that risk costs can be reduced by applying modern techniques of countering financial risks including various types of insurance. The generalized model of managing the risk of an innovative project is proposed; the model includes the stages of developing probable measures to counter risks and making decisions on the choice of the preferred option. The probable types of innovation project risks, techniques for their assessment under uncertainty are considered. The mechanisms of countering innovation risks are analyzed, including types of project risk insurance. The decision tree was formed on the choice of a technique for countering the risk on the basis of a number of its characteristics defined in the qualitative and classification scale. The technique for selecting a mechanism for insuring project risks, taking into account the probabilities of specific risks, their costs and the general insurance fund of the project is presented in a formalized view. The process model was developed to select the preferred technique of insurance taking into account the integral assessment of the innovation risk. The use of the developed models in planning the processes of managing the risk of an innovative project increases the validity and reliability of decisions on the choice of a method for countering risks by taking into account the characteristics of specific risks, the magnitude of the integral risk and features of a particular project.
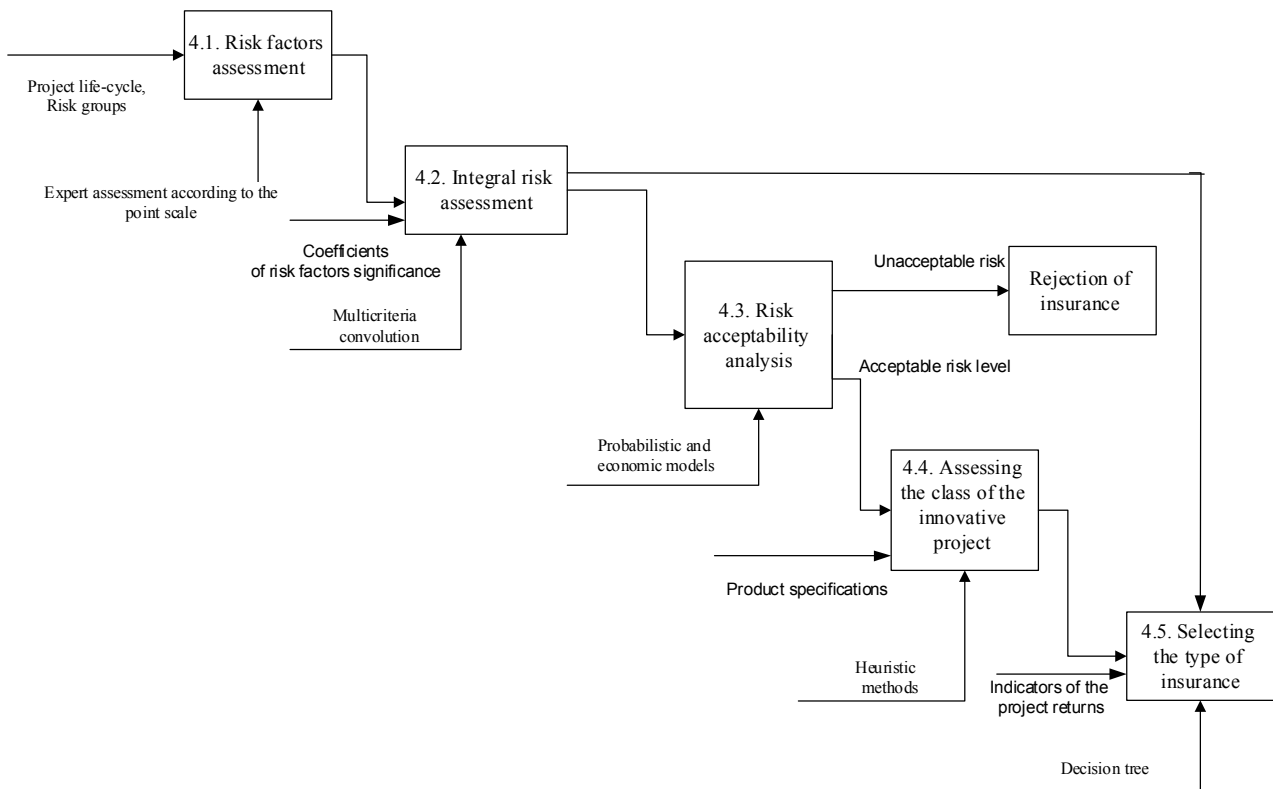
Fig. 4. The process model for selecting a type of a project insurance basing on the integrated assessment of an innovation risk

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Модели процесса принятия решений по выбору способов парирования рисков инновационного проекта

В. В. Косенко

Предметом исследования в статье являются риски инновационного проекта. **Цель статьи** – разработка моделей процесса принятия решений по выбору способов парирования рисков инновационного проекта. Решаемые **задачи**: анализ особенностей управления рисками инновационного проекта, разработка обобщенной модели процесса управления рисками проекта, анализ механизмов парирования инновационного риска, разработка дерева решений для выбора способа парирования рисков инновационного проекта, разработка формализованного метода и процессной модели выбора предпочтительного способа страхования риска. Применяемые **методы**: системный анализ, проектный подход, риск-ориентированный подход, эвристические методы принятия решений, процессные модели. **Полученные результаты**. Проведенный анализ особенностей управления рисками инновационного проекта показал возможность снижения стоимости рисков путем применения современных методов парирования финансовых рисков, в том числе страхования в различных его формах. Предлагается обобщенная модель процесса управления рисками инновационного проекта, которая включает этапы выработки возможных мер по парированию рисков и принятие решения по выбору предпочтительного варианта. Рассмотрены возможные виды рисков инновационного проекта, методы их оценки в условиях неопределенности. Проанализированы механизмы парирования инновационных рисков, в том числе и виды страхования рисков проекта. Сформировано дерево решений по выбору способа парирования риска на основе ряда его характеристик, определенных в качественной и классификационной шкале. Формализован представленный метод выбора механизма страхования рисков проекта с учетом вероятностей частных рисков, их стоимости и общего страхового фонда проекта. Разработана процессная модель выбора предпочтительного способа страхования с учетом интегральной оценки инновационного риска. **Выводы**. Применение разработанных моделей в планировании процессов управления рисками инновационного проекта повышает обоснованность и достоверность решений по выбору способа парирования рисков путем учета характеристик частных рисков, величины интегрального риска и особенностей конкретного проекта.

Ключевые слова: инновационный проект; вероятность риска; снижение риска; методы парирования; страхование.

Моделі процесів прийняття рішень з вибору способів парирування ризиків інноваційного проекту

В. В. Косенко

Предметом дослідження в статті є ризики інноваційного проекту. **Мета статті** – розробка моделей процесів прийняття рішень для вибору способів парирування ризиків інноваційного проекту. **Завдання,** які вирішуються: аналіз особливостей управління ризиками інноваційного проекту, розробка узагальненої моделі процесу управління ризиками проекту, аналіз механізмів парирування інноваційного ризику, розробка дерева рішень для вибору способу парирування ризиків інноваційного проекту, розробка формалізованого методу і процесної моделі вибору кращого способу страхування ризику. Застосовувані **методи:** системний аналіз, проектний підхід, ризик-орієнтований підхід, евристичні методи прийняття рішень, процесні моделі. **Отримані результати.** Проведений аналіз особливостей управління ризиками інноваційного проекту показав можливість зниження вартості ризиків шляхом застосування сучасних методів парирування фінансових ризиків, в тому числі страхування в різних його формах. Пропонується узагальнена модель процесу управління ризиками інноваційного проекту, яка включає етапи вироблення можливих заходів щодо парирування ризиків і прийняття рішення щодо вибору кращого варіанту. Розглянуто можливі види ризиків інноваційного проекту, методи їх оцінки в умовах невизначеності. Проаналізовано механізми парирування інноваційних ризиків, в тому числі і види страхування ризиків проекту. Сформовано дерево рішень по вибору способу парирування ризику на основі ряду його характеристик, визначених у якісній і класифікаційній шкалах. Формалізовано представлений метод вибору механізму страхування ризиків проекту з урахуванням ймовірностей часткових ризиків, їх вартості та загального страхового фонду проекту. Розроблено процесну модель вибору кращого способу страхування з урахуванням інтегральної оцінки інноваційного ризику. **Висновки**. Застосування розроблених моделей в плануванні процесів управління ризиками інноваційного проекту підвищує обґрунтованість і достовірність рішень по вибору способу парирування ризиків шляхом урахування характеристик часткових ризиків, величини інтегрального ризику та особливостей конкретного проекту.

Ключові слова: інноваційний проект; ймовірність ризику; зниження ризику; методи парирування; страхування.