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# RISK MANAGEMENT OF REGIONAL INNOVATION PROCESSES

*The article summarizes the methodology for assessing the risks of innovative projects. A methodological approach to the formation of an investment program for territorial innovation clusters is proposed. An approach to forming teams of innovative projects has also been developed, characterized by the completeness of technical and entrepreneurial competencies, which makes it possible to formulate an investment program for the cluster by selecting the optimal combination of project options. This ensures a maximum of net present value within a given time frame, with a limited funding fund, and, in addition, a given value of an integrated quality indicator reflecting the level of achievement of the global goal of the cluster. Qualitative and quantitative methods of risk assessment are considered; it was concluded that innovative projects are in dire need of government support in the early stages of implementation in order to reduce the degree of uncertainty and riskiness of their implementation. Based on economic and mathematical models of decision-making by cluster participants, a mechanism for coordinating the interaction of subjects has been formed, which makes it possible to coordinate the interests of participants in financing an innovative project within the framework of the concept of single-level interaction of economic agents. The area of compromise that is necessary for consultations and negotiations, as well as for making management decisions on territorial innovation clusters, has been quantitatively determined. To minimize risks and increase the efficiency of budget financing, a risk management mechanism is proposed, which involves identifying the main risk factors at each stage of the innovation process and using government support tools aimed at minimizing them. The methodology for assessing the risks of innovative projects is generalized, qualitative and quantitative methods of risk assessment are considered; it was concluded that innovative projects are in dire need of government support in the early stages of implementation, in order to reduce the degree of uncertainty and riskiness of their implementation; To minimize risks and increase the efficiency of budget financing, a risk management mechanism is proposed, which involves identifying the main risk factors at each stage of the innovation process and using government support tools aimed at minimizing them.*

***Keywords:*** *risks, management model, innovation processes, regional development, minimization.*

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# УПРАВЛІННЯ РИЗИКАМИ РЕГІОНАЛЬНИХ ІННОВАЦІЙНИХ ПРОЦЕСІВ

*У статті узагальнено методологію оцінки ризиків інноваційних проектів. Запропоновано методологічний підхід до формування інвестиційної програми територіальних інноваційних кластерів. Також розроблено підхід до формування команд інноваційних проектів, що характеризується повнотою технічних та підприємницьких компетенцій, що дозволяє сформувати інвестиційну програму кластера шляхом відбору оптимальної комбінації варіантів проектів. Це забезпечує максимум чистого дисконтованого доходу у задані терміни, з обмеженим фондом фінансування, та, крім того, задане значення інтегрованого якісного показника, що відображає рівень досягнення глобальної мети кластера. Розглянуто якісні та кількісні методи оцінки ризику; зроблено висновок про те, що інноваційні проекти гостро потребують державної підтримки на ранніх стадіях реалізації з метою зниження ступеня невизначеності та ризикованості їх реалізації. На основі економіко-математичних моделей прийняття рішень учасниками кластеру сформовано механізм узгодження взаємодії суб'єктів, що дозволяє узгодити інтереси учасників фінансування інноваційного проекту у рамках концепції однорівневої взаємодії економічних агентів. Кількісно визначено область компромісу, яка необхідна для ведення консультацій та переговорів, а також прийняття управлінських рішень щодо територіальних інноваційних кластерів. Для мінімізації ризиків та підвищення ефективності бюджетного фінансування запропоновано механізм управління ризиками, що передбачає виділення основних факторів ризику на кожній із стадій інноваційного процесу та використання інструментів державної підтримки, спрямованих на їхню мінімізацію. Узагальнено*

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*методологію оцінки ризиків інноваційних проектів, розглянуто якісні та кількісні методи оцінки ризику; зроблено висновок про те, що інноваційні проекти гостро потребують державної підтримки на ранніх стадіях реалізації з метою зниження ступеня невизначеності та ризикованості їх реалізації; для мінімізації ризиків та підвищення ефективності бюджетного фінансування запропоновано механізм управління ризиками, що передбачає виділення основних факторів ризику на кожній із стадій інноваційного процесу та використання інструментів державної підтримки, спрямованих на їхню мінімізацію.*

***Ключові слова:*** *ризики, модель управління, інноваційні процеси, регіональний розвиток, мінімізація.*

**Formulation of the problem**. In the modern period of development of innovative activity, thanks to the participation of state institutions, innovative projects are given the opportunity to receive financial and organizational support at all of the above stages of their implementation. Mechanisms for budgetary support of innovative projects, especially at stages (stages) of their implementation, provide the opportunity that some risk factors are minimized or eliminated, and their overall level is significantly reduced [6].

The implementation of a number of the above stages of innovative projects may require the use of public budget investments, especially at the following stages: stages of experiments or research; stages of scientific and technical expertise and internal express analysis of the project; R&D stage. With the help of state participation in project financing, two tasks are solved: the project receives a further opportunity for its implementation; project risk levels are minimized.

**Analysis of basic research and publications.** The study of theoretical and practical aspects related to the problems of risk management in enterprise is significant and includes scientific works from leading Ukrainian and foreign studies, among them: V. Apopii, A. Algina, I. Balabanova, G. Bashnyanin, O. Bila, I. Blank, V. Granaturov, G. Velikoivanenko, E. Velichko, V. Vitlinsky, L. Donets, V. Zagorsky, S. Illyashenko, V. Cherkasova, O. Ustenko, E. Utkina, A. Mazaraki, N. Mashina, B. Mizyuk, S. Nakonechny, G. Kleiner, V. Tochilin, M. Khokhlova, K. Khlarden, A. Stefanich, O. Yastremska and others, particularly those dedicated to the study of related aspects the essence of risks, their analysis, significant factors and reasons for their guilt and management. At the same time, it should be noted that the main approaches and methods to overcome other problematic aspects of risk management as a functioning risk management system are not sufficiently illuminated, therefore require greater respect in Anna with foreign evidence and protection of criminal characteristics.

Therefore, the **purpose** of the article is to develop a risk management mechanism that involves identifying the main risk factors at each stage of the innovation process and using government support tools aimed at minimizing them.

**Presentation of the main material**. Risks, especially the risks of non-realisation of innovation projects, occupy a significant place in innovation activities. In this paper, the risks of innovation activity are interpreted "as probabilities of losses that could potentially occur in the production of innovative products (services), development of new technologies or new types of equipment, determined by the fact that these products or technologies may not have the expected demand in the market, as well as in R&D and implementation of organisational, managerial and marketing innovations that will not produce the planned effect" [8].

In the theory of risk assessment, that is, the assessment of potential damage, there are qualitative and quantitative risk factors. Qualitative risk factors are assessed using a quantitative approach and are based on the fact that there are two types of uncertainty [2]:

– In the first case, when the events under study are rarely or never observed in the past, i.e. they can only be realised for the first time in the future, then there is non-statistical uncertainty. Here we can use the subjective probability of the event realisation, which is determined with the help of expert estimates of its parameters. This approach (subjective-probabilistic), is based on the degree of confidence of the expert in the fact that the event will take place, rather than on the statistical frequency or sampling of the manifestation of the event in the past.

– In the second case, when uncertain parameters occur frequently, the frequency of occurrence of these parameters can be determined by applying statistical information for estimation or through simulation experiments. This type of uncertainty belongs to the class of statistical uncertainty.

Let us consider the first case – assessment of qualitative risk factors under non-statistical uncertainty. At present, there are quite a large number of methods for assessing qualitative risk factors under non-statistical uncertainty. There is also a considerable number of expert methods: ranking method, point method, method of pairwise comparison and Delphi method. In order to reduce the subjectivity of expert opinions, the whole set of expert assessments is aggregated into a single result. Here it is also appropriate to cite such methods as:

– risk map, which allows to compare different risks, prioritise them for further development of risk management procedures;

– the method of analogy, based on the analysis of the provided information similar projects, or projects realised under similar conditions, which involves analysing errors as well as potential problems;

– the decision tree method, which is based on a branching scheme of events, reflecting the sequence of actions performed, as well as their results, taking into account the probabilities of achievement.

All the above methods are based on subjective perceptions of experts, which are further reduced to the definition of an integral indicator. They require certain adaptation to the specifics of risk assessment of innovation projects.

The most effective is the method of expert risk assessments carried out at various stages of an innovation project. For each stage of the project a list of individual risk factors characterised by the indicators of their specific weight and priority, as well as their totality is formed. A comprehensive risk assessment, represented by an integral assessment of all stages of the innovation project represents the probability of successful implementation of this project.

To "reduce the factors of subjectivism, a direct mechanism of expertise is used, which provides a more objective assessment. In this case, the dominant strategy of expert judgement is to provide reliable information" [7].

The generalized expert assessment is determined according to the following rule:

$$s_i = \max_{k=1,K} \min(r_{i,k}, w_{i,k-1}), \quad (1)$$

where $r_{i,k}$ is the value of the assessment parameter by the k-th expert of the i-th factor;

$w_{i,k}$ – element of a numerical decreasing sequence;

K – number of experts.

The use of formula (1) assumes the location of the presented expert assessments according to their ascending order.

Next, we introduce into the study a decreasing numerical sequence w:

$$w_k = \pi(\underbrace{d,...,d}_{i},\underbrace{D,...,D}_{K-i}),\ k = \overline{0,K}, \quad (2)$$

where π(...) is the convolution function of estimates (arithmetic mean convolution);

d – the minimum possible value of the parameter assessment by the expert;

D is the maximum possible estimate of the parameter by the expert.

We find that for the sequence w, a fixed number of experts are required who report the minimum estimates, and the rest report the maximum. By varying the number of experts who reported minimum ratings from 0 to K, we obtain a decreasing sequence of points.

Point $w_0$ graphically coincides with the right boundary of the maximum possible values of D. In the case when all experts reported the maximum assessment values, then by unanimous consent this decision will be made. Otherwise, when all experts have reported a lower estimate d, then a decision equal to $w_K$ will be made.

From here, we get two sequences of numbers: the first is represented by an increasing sequence of expert estimates r, and the second is a decreasing sequence of points w. It is a priori stated that in any case these sequences will intersect. The rightmost point of intersection of these sequences, calculated according to rule (1), represents an objective assessment of the examination being carried out. It is also clear that the significance of a risk factor is closely related to the concept of priority [8]. In the case when the priorities $\alpha_i$ of risk factors are predetermined, then it is possible to set the function ξ(·) to recalculate the priorities in the importance of factors.

For example: let three priority levels be preset – 1, 2, 3. The first priority determines the minimum value, and the last priority determines the maximum value. Let us assume that the ratio corresponding to the first and third priorities is equal to – Q. We denote all risk factors in the third priority as x, then the arithmetic mean in the first priority will be equal to Qx. The weight of the risk factor in the second priority is expressed as (Q+1)x/2.

In the case when N risk factors are taken into account, the specific weight of the risk factor in the third priority will be equal to – Q/N: the maximum risk will be equal to Q·N, and the minimum – N.

Taking into account the above considerations, a comprehensive risk assessment for all qualitative indicators that have non-statistical uncertainty is calculated as follows:

$$R_{NU} = \sum_{i=1}^{N} \xi(\alpha_i) \max_{k=1,K} \min(r_{i,k}, w_{i,k-1}), \quad (3)$$

Next, we will consider the second case: the assessment of qualitative risk factors under conditions of statistical uncertainty. In this case, risk factors can be aggregated into a comprehensive assessment of their parameters, taking into account the likelihood of their implementation. Expert assessment of these parameters is also carried out on the basis of a direct examination mechanism. We obtain a formula for a comprehensive risk assessment based on qualitative parameters that have statistical uncertainty [5]:

$$R_{SU} = \sum_{j=1}^{M} p_j \max_{k=1,K} \min(r_{j,k}, w_{j,k-1}), \quad (4)$$

where $r_{j,k}$ is the assessment of the kth expert of the jth risk factor;

$p_j$ – probability of risk factor realization (the ratio of the number of risk factor realizations to the total number of considered events);

M – is the number of qualitative, statistically uncertain risk factors.

Next, we present an assessment of quantitative risk factors. Since an innovative project is characterized by quantitative indicators, the likelihood of their deviations from standard values poses certain risks. To evaluate them, we introduce the concept of reliability of an innovative project, showing the degree of confidence in its successful implementation.

Quantitative criteria for assessing the reliability of a project are:

DROI – discounted indicator (criterion) of return on investment in the project;

DPP – project payback period taking into account discounting;

SR – sensitivity of the project or safety margin of the project according to the main parameters.

Indicators are assessed according to the DROI criterion using the formula [4]:

$$R_{DROI} = \frac{DCF_{oper} - DCF_{INV}}{DCF_{INV}} = \frac{NPV}{DCF_{INV}} = PI - 1, \quad (5)$$

where $DCF_{oper}$ – represents the discounted cash flow from the operating activities of the organization;

$DCF_{INV}$ – represents discounted cash flow from investment activities;

NPV is the net present value of the project;

PI – project profitability index.

The assessment of indicators according to the DPP criterion is carried out according to the formula:

$$R_{DPP} = 1 - \frac{DPP}{T}, \quad (6)$$

where DPP – represents the discounted payback period of the project;

T – is the probable horizon for assessing performance indicators.

Project sensitivity (SR) is a margin of safety of the project, characterizing the extent to which its performance indicators depend on fluctuations in the key parameters of the project (volume of investment, product value, direct costs, sales volume, etc.). The sensitivity rating (SR) contains values from 0 to 1, characterizing the level of probability of obtaining a positive NPV of an innovative project with possible deviations of the project parameters from the specified target values. The higher the indicator (SR) project, the less sensitive the project is to changes in key parameters and the higher the likelihood of achieving a positive NPV. If the same values of other criteria are obtained, the project with a large value of the indicator (SR) is given priority for inclusion in the investment program.

It should be noted that none of the proposed approaches to assessing the risk factors of an innovation project covers all stages of its implementation.

Each of the approaches provides the opportunity to assess the level of risk of certain characteristics for certain stages of project implementation and to determine the main risk factors that require minimization. To obtain a comprehensive assessment of the risk factors of innovative projects, it is necessary to use these methods together.

**Conclusions**. We note that it is impossible to completely eliminate the risks inherent in innovative projects, so it is necessary to manage them in order to minimize the level of their impact. The state, as one of the participants in the innovation process, takes an active part in identifying and managing the risks of innovative projects.

Based on the risk assessment, we can conclude that innovative projects are in dire need of government support in the early stages of their implementation.

Private investments are not made in high-risk innovative projects. Therefore, one of the main goals of government measures to support projects is to reduce their uncertainty and riskiness of implementation to a level that is acceptable to potential investors.

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