Asian Journal of Research in Business Economics and Management
ISSN: 2249-7307 Vol. 12, Issue 2, February 2022 SJIF 2022 = 8.529
A peer reviewed journal

RISK ASSESSMENT OF INVESTMENT PROJECTS IN THE CONTEXT OF THE DEVELOPMENT OF THE INNOVATION PROCESS OF ENTERPRISES

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DOI: 10.5958/2249-7307.2022.00016.0

ABSTRACT

The article deals with the problem of choosing investment projects and its further continuation or suspension. The evaluation of each investment project is usually a multi-dimensional problem, as the issue of financial analysis is considered, and technical, social and environmental factors are also taken into account. While financial criteria are usually quantitative in nature, others are often based on qualitative judgments. In particular, the high level of risk of investment projects is usually a key indicator on the path of innovative development. Development of enterprises accompanying innovation and investment activities. The study of methods of analysis and risk assessment of investment projects is designed to minimize the probability of force majeure in the development of innovative projects. Since the analysis of each project is based on vague assumptions, the problem can be considered as a discrete stochastic decision problem with multiple criteria. To solve this problem, we use stochastic dominance rules and the multi-criteria auxiliary procedure PROMETHEE II. While the modeling method is used to obtain a financial assessment of projects, expert opinions are taken into account to evaluate the project against other criteria. Thus, this approach takes into account quantitative and qualitative factors.

KEYWORDS: *Investment Project, Risk, Evaluation, Innovation, Qualitative And Quantitative Factors, PROMETHEE II.*

1. INTRODUCTION

The main constraint on the innovation activity of enterprises and organizations is traditionally the high level of risk that accompanies innovative projects (Kaleev, 2011) **[1].** In addition, the COVID-19 pandemic is undoubtedly one of the most serious challenges the world has ever faced (Ramalingam & Prabhu, 2020) **[2].** In this regard, global challenges will radically change the socio-economic relations and interaction between states and economic entities in states require concentration and pooling of opportunities at all levels, determine the need to adjust the national strategy of socio-economic development and its innovative reorientation, encourage the fundamental formation of new approaches to managing innovation activities of

economic entities.

The necessity and relevance of research on innovative projects in the context of risks and today's global challenges combined with the processes of integration, simultaneous Neo-industrialization and de-industrialization are confirmed by the works of foreign authors Barton, Schenkeri and Walker (Floricel & St-Pierre, 2003) **[3]**, which emphasize the beginning of the process of forming the last stage of society development - the "risk society" - and argue that humanity has already entered this stage of development (Astanakulov et al., 2020) **[4].** This is due to the fact that in modern conditions, most threats and risks are no longer local in nature, but become global. The main problem of future economic growth will be not so much the growing need for funds to finance new investments, but rather the need to reserve capital to meet the needs that will be caused by risks.

To ensure the objectivity of the analysis of the effectiveness of an enterprise's innovation activity, it is necessary to quantify the risks of an innovation project. The assessment of innovative risks is presented to us as an analytical procedure, during which risk parameters are identified and determined. The complex and multidimensional nature of innovative projects of enterprises, their impact on various areas of the organization's activities requires taking into account a huge number of risk factors. At the same time, non-economic factors are particularly difficult to assess. Specified circumstances they determine the predominance of qualitative assessments of innovation risks over quantitative ones.

2. THEORETICAL AND METHODOLOGICAL ASPECTS AND HYPOTHESES

Innovation project risk is the probability that the company will incur losses either in the form of additional costs beyond the forecast; or due to exceeding the planned deadlines for implementing the stages of the innovation project; or due to loss of time due to the risk associated with commercialization of innovations in the market; or receive revenue below expected (Hertz, 1979) **[5].** These types of resource losses lead to a possible loss of profit (Shevchenko & Ustinovichius, 2010) **[6]** when implementing an innovative project compared to the forecast option. The procedure for assessing and analyzing project risks can be presented in the following diagram (see Figure 1).

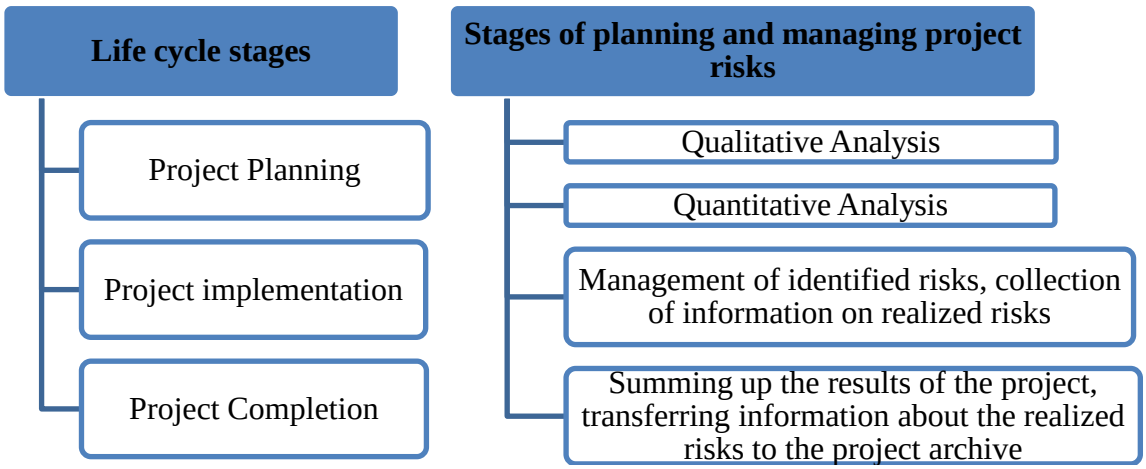

FIGURE 1 RISK ASSESSMENT AND MANAGEMENT PROCEDURE

Based on the results of the project implementation, statistics are accumulated that allow us to more accurately identify risks and work with them in the future (Maria Goreti usboko, 2018) **[7].** If the uncertainty of the project is too high, then it can be sent for revision, after which the risk assessment is performed again. Table 1 shows the list of risks of innovative projects

(Tarasova et al., 2017) **[8]** (Shaturaev & Jumaev, 2019). **[9]**

TABLE 1 THE MAIN GROUPS OF RISKS OF AN INNOVATIVE PROJECT AND SOME WAYS TO MINIMIZE THEM

Sr. No.	Groupsrisk assessment	Description of key factors	Ways to minimize risks
1.	Research and development risks	• negative R & D result; • low R & D efficiency; • non-compliance of R & D results with the production capabilities of the enterprise.	• use of the most modern and effective R & D methods; • selection of qualified personnel for R & D; • conclusion of R & D contracts with reliable partners.
2.	Risks associated with intellectual property rights	• risks of parallel licensing; • risks of unauthorized access to know-how; • risks of illegal use of intellectual property rights; • risks of patent conflicts when expanding the geography of sales.	• umbrella patenting; • creation of a system for monitoring the use of know-how; • expanding the patent geography • distribution (patent registration with the national patent offices of the country where the product is planned to enter the market); • marketing and patent monitoring.
3.	Financial risks	• threat of lack of funding • sources; • threat of deterioration of financial leverage; • the threat of the source of funding disappearing.	• diversification of loan capital sources; • planning the optimal capital structure; • phased implementation of investments to ensure the division of the loan into tranches.
4.	Production risks	• risks of a high share of fixed costs; • risks associated with the presence of specific assets, causing the threat of non-return on investment.	• application of new resource-saving technologies • technologies; • liquidation of non-core (excess) assets; • optimization of the number of administrative staff.
5.	Contractual risks	• disruption of negotiations and disclosure of information received; • contractors ' refusal to cooperate further; • changing the business environment.	• conclusion of long-term contracts; • expanding the circle of counterparties.
6.	Sales risks	• threat of lack of sales of products; • risk of incorrect choice of pricing policy; • risk of breaking the contract with sales agents.	• thorough analysis and segmentation of the market at the product planning stages; • conclusion of preliminary supply contracts with proven and qualified trading companies.

Methodological tools for assessing the level of investment risk include economic and

statistical, expert and analog methods for making such an assessment. Operational analysis should be added to this classification as a method for assessing the degree of entrepreneurial risk, i.e. "risk in general"(Report, 2019) **[10].** Economic and statistical methods form the basis for assessing the level of investment risk (Gorokhovatskyi et al., 2021) **[11].** Expert methods for assessing the level of investment risk are used if the company does not have the necessary informative data for making calculations using economic and statistical methods (Brans & De Smet, 2016) **[12].** The use of analog methods at the stage of pre-investment planning of an innovative project is almost impossible, since there is no basis for comparison.

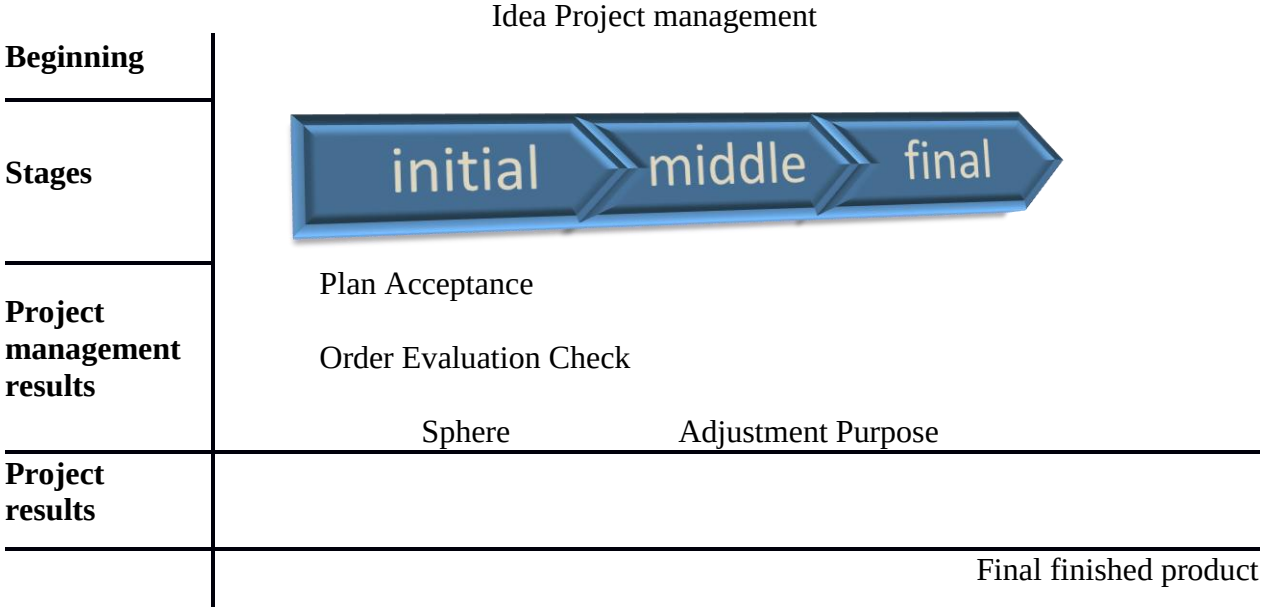

FIGURE 2 TYPICAL SEQUENCES OF PROJECT LIFECYCLE STAGES

The complexity of risk management is explained by the integral impact of various factors of the external and internal environment on investment processes. The variety of risk factors complicates the process of obtaining initial data and conducting the assessment itself risk management. In this regard, among the possible methods for assessing the risk of investment projects, it is necessary to use only those methods that take into account the multi-criteria and multi-variant impact different types of risk on investment processes (R. Karlibaeva, 2021) **[13].**The method of risk assessment based on the econometric approach is based on taking into account all risk generating factors at each moment time of implementation of the investment project, grouping of these parameters. factors based on the main classification criteria and quantitative assessment of the level of risk, expressed in determining the size of the company's assets. costs of probable risk events.

Figure 3. shows the relationship between investment risk before the product implementation period. P_1, P_2, R_3 risk indicators for the entire implementation period. It should be noted that the initial period of project implementation usually has a high risk and before the final result of the project implementation, you can see a decline in risk indicators, which indicates that the risk decreases before the final period (Shevchenko & Ustinovichius, 2010) **[6].**

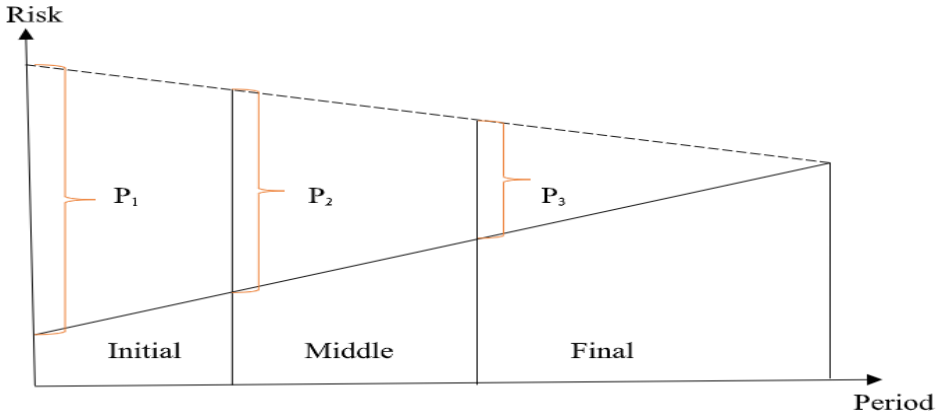

FIGURE 3 GRAPHIC REPRESENTATION OF RISK UNCERTAINTY REDUCTION IN THE IMPLEMENTATION OF AN INVESTMENT PROJECT

The economic risk analysis (and risk assessment model) should take into account some specific characteristics in which the enterprise operates (Jensen & Smith, Jr., 2005) **[14].** First, it is necessary to analyze the business environment, the potential and position of the enterprise in the market, its market share, the quality and competitiveness of products or services provided (О.Астанакулов, Х.Асатуллаев, 2018) **[15].** At this initial stage, a preliminary analysis of the business environment makes it possible to make a general assessment of the enterprise's risk profile before using any specific analytical methods and methodologies.

In particular, the economic risk assessment model should meet certain requirements, namely (Yosifov & Taneva, 2018) **[16]**:

First, the model should provide some results based on an objective assessment of risk factors that shape the specific conditions of the environment in which an innovative enterprise operates.

Secondly, the choice of indicators of the business environment and their determining factors, respectively, should be made on the basis of their relationship with the overall financial condition of the enterprise.

Third, the model should not be too complex to apply.

Fourth, the indicators included in the model are determined based on the importance of assessing economic risk in the current period. However, to assess the economic efficiency of an enterprise and, in particular, its innovation activity, it is necessary to take into account possible changes in environmental parameters, as well as factors that provoke them.

Fifth, the selection of data is based on a relatively wide range of sources, such as an overall assessment of the company's project plans, its accounting records, and statistics on the state of the business environment, the economic sector, and the region in which it operates and sells its products.

Sixth, a process-based approach should be applied to risk assessment, i.e. the model should be based on following a specific sequence of actions defined as the composite phases of the model (Usman & Mikhailova, 2020) **[17]** (Floricel & St-Pierre, 2003) **[3].** In this regard, skipping or changing a certain phase may lead to an unrealistic assessment of risk factors and the final investment decision of the investor.

The study is based on confirmation of the following empirical hypotheses:

Hypothesis 1-the study of the effectiveness of innovative activity of the enterprise is determined. the need for a reliable quantitative assessment of the local and aggregate level of risks of innovative projects, as well as the strength of impact.

Hypothesis 2 - the presence of certain features of innovative projects, which are determined by a high degree of uncertainty and risk associated with the phases of the project's life cycle and its target orientation.

Hypothesis 3 - each phase (stage) of the life cycle of an innovative project has its own characteristics, taking into account different types of risks, differing in content and main causes.

Hypothesis 4-each innovative project can be characterized by performance indicators in terms of costs, revenue, and timing, which form a set of target risks of an innovative project (risk of overspending, risks of underfunding, risks of overspending time for the implementation of project stages).

3. RESEARCH METHODS

Studying the effectiveness of innovation processes and taking into account the planning, development, implementation and management of innovative projects, first of all, the state of system management of a dynamic object under the influence of external, and internal factors are necessary (Nikolova et al., 2015) **[18].** In this regard, the purpose of the article is to develop a systematic dynamic complex model for generating and assessing risks of an innovative project, on the basis of which scenario modeling of the impact of many risks that arise at certain stages of project implementation in the target territory is built.

3.1. Data sampling and collection.

Let's group the methods that are suitable for assessing the risks of innovative projects (Kaleev, 2011) **[1]:**

1) the accounting method (observation) is an integral tool for assessing innovation risks, as a rule, the starting point of this procedure the method operates with quantitative and qualitative indicators that characterize various aspects and forms of risk manifestation (Xiaoyu, 2014) **[19].** However its practical use is largely limited by its complexity and complexity. originality of innovative projects;

2) the comparison method is one of the most common evaluation methods. It is used both for processing primary information and for determining the ranks and rating assessments of innovative risks (Bekefi et al., 2008) **[20]**;

3) the point-based assessment method (expert method) is easy to use, does not require any additional training. requires special mathematical tools or software. Allows you to get an integral risk assessment using the following methods: heterogeneous qualitative and quantitative initial parameters (G. Bekimbetova, 2020) **[21].** The main disadvantage of this method is the high qualification requirements experts, subjectivity of evaluation results;

4) the method of analogies is based on the analysis of all available data concerning the implementation of similar innovative projects in the past. The generated source database can be used for plotting the risk curve and calculating the probability of loss occurrence (Floricel & St-Pierre, 2003) **[3].** The scope of application of the method in the innovation sphere is very limited. Method it can't be used for innovative projects of a radical nature. a

character that has no analogues;

5) the statistical method has a fairly wide scope of application: it can be used for processing expert assessments and calculating the frequency of the event. the occurrence of risk events, standard deviations of indicators, coefficient of variation, and other statistical indicators. The advantages of the method include a relatively simple mathematical apparatus and the validity of the results, while the disadvantages include the need to take into account standard requirements for source data arrays, which may not always be fulfilled in relation to the subject matter researches;

6) the risk-adjusted discount rate method. The method provides for an increase in the discount rate used in calculations (risk-free rates) on the value of the "risk premium". The latter will allow you to take into account the additional income required by the investor in excess of the level that they can bring risk-free investments. The risk premium is calculated based on information about past and projected events using statistical packages;

7) The "decision tree" method (G.Bekimbetova, 2019) **[22]** is used to assess the risks of projects with a significant number of development options. For each of the selected The integral economic coefficient is calculated for project development scenarios. effect and probability of this scenario implementation;

8) Sensitivity analysis is an assessment of how much changes will occur. the economic effect of an innovative project when one of the initial project parameters is changed in a certain way. Even if it is insignificant deviation of a parameter relative to its original value has the following effects: if the project has a significant impact on the result, then this project is considered sensitive to changes in this parameter (the stronger the dependence, the better higher risk) (Akitoby & Stratmann, 2008) **[23].** The disadvantages of this method are limited scope its applications, as well as univariate - simultaneous change several parameters of the innovation project are not provided. In addition, the probability of changes in the project parameters considered by this method is not considered;

9) Scenario analysis is a development of the sensitivity analysis technique, because it allows you to account for simultaneous consistent changes groups of variable factors that are tested for risk. Most often in this in this case, the calculation is based on three possible scenarios: pessimistic, optimistic, and most likely;

10) modeling (Gorokhovatskyi et al., 2021) **[11]** is one of the most complex methods analysis. The use of this method is most effective in relation to clearly structured objects, which are most often not used by the user. these include innovative projects. In practice, Monte Carlo simulation is most often used to assess innovation risks. This method is quite complex with from a mathematical point of view and requires appropriate software security features.

3.2. Formation and assessment of a set of risks of an innovative project by components, nature and strength of impact.

The presented list of methods for assessing the risks of innovative projects, identifying the areas of their application, advantages and disadvantages, of course, is not necessary. it is absolutely complete. However, an important result of the study is it is necessary to use in practice an integrated approach to the problem under study. This provides for simultaneous use of the following methods: research from various scientific fields and fields of activity.

3.3. Modeling of Innovative Project Development Scenarios.

It should be noted that in recent years PROMETHEE II has become one of the most effective

and successfully applied methods for evaluating results in multi-criteria decision-making tasks (Brans & De Smet, 2016) **[12]** (Stamalevi, 2015) **[24].** The traditional PROMETHEE II method assumes that the weights of the criteria are known in advance, and this is a rather rigid assumption. Moreover, the number of preference indexes that need to be evaluated in the method increases enormously with the number of alternatives that need to be ranked. In this paper, we address these issues and propose A methodology inspired by PROMETHEE II, which first determines the best criteria, and then preference indexes are calculated only against these criteria. The algorithm is configured in such a way that it significantly reduces the computational time complexity of PROMETHEE II. Here, a large number of alternative criteria evaluation matrices are modeled with random numerical data to illustrate the proposed method and evaluate its effectiveness.Statistical analysis of rating stability and compliance measures proves that the proposed approach may be preferable to the PROMETHEE II and TOPSIS methods (Brans & De Smet, 2016) **[12].** Rank correlation coefficients are estimated, which indicate the effectiveness of the proposed method.

4. Imperative analysis of results

4.1 Descriptive analysis

The choice of a particular combination of methods (Nikolova et al., 2015) **[18],** according to the author, should be determined by availability of information, the degree of urgency of obtaining the result, the composition and professional qualifications, and other factors. The terms innovation and growth are so closely related, it's no wonder that almost 9 out of 10 organizations innovate in at least one of eight ways - or say that they plan to do so in future years. And so technology development is at the heart of innovation in all its forms, and that greater initiatives are being implemented on the basis of new technologies to improve existing products - 86% and almost 80% is being spent on creating new ones.

TABLE 2 INNOVATION ACTIVITIES CARRIED OUT IN 2020 (PWC, 2018)

Sr. No.	Name	Today	During3 years	Result
1.	Implement new technologies to significantly improve the existing products or customer experience	60%	26%	86%
2.	Implement new technologies to develop new products or to target new customers	53%	27%	80%
3.	Change your HR strategy	42%	28%	70%
4.	Form a strategic alliance (s)	44%	24%	68%
5.	Enter new markets	41%	27%	68%
6.	Create new products or services outside of our site suggestions for entering a new industry	35%	23%	58%
7.	Change the distribution model	35%	23%	58%
8.	Make a strategic deal to enter a new industry	22%	19%	41%

Artificial Intelligence (AI) and Internet of Things (IOT) deployments are also underway or planned and are expected to increase in impact in the coming years as organizations tap into the potential of these technologies.

TABLE 3 THE MOST IMPORTANT INNOVATIVE ACTIVITIES CARRY INCREASED RISKS (PWC, 2018) **[25]**

Events	**Risks**			
57%	Implement new technologies for significantly improve existing products or customer experience	Cyber security or privacy threats	Technological risk	Operational risk
		75%	**69%**	**53%**
42%	Implement new technologies for develop new products or target new clients	Cyber security or privacy threats	Technological risk	Regulatory or compliance risks
		75%	**73%**	**61%**

The net present value of the project NPV (Arjunan, 2017) **[26]** was used as an indicator of the effectiveness of the investment project:

where is NCF_t- the value of the net payment flow in the period t, r – discount rate; t - serial number of the project implementation period; I_0- initial investment (Milano, 2017) **[27]** .Based on the available initial data in the course of the subject area study, risk factors affecting changes in the values of cash flows and the net present value of the project as a whole were identified (Table 2).

TABLE 4 INVESTMENT PROJECT RISK FACTORS

Deterministic factors	**Stochastic factors**
1. Fixed costs F	1. Product sales volume Q
2. Depreciation charges A	2. Unit price P
3. Interest rate on borrowed funds T	3. Variable costs per unit of production V
4. Discount rate r	
5. Project implementation period n	
6. The amount of initial investment.$_0$	

The payment flow generated by the project has the form of an annuity. Then the value of the NCF payment flow is$_t$, for any period t is the same and can be determined from the relation that reflects the mathematical model of the simulation experiment (Žižlavský, 2014) **[28]**:

In the course of conducting simulation experiments, models of cash flows arising during the implementation of an investment project are constructed. At the same time, the obtained values of the net present value of the project (NPV) and the value of the net payment flow over time t (NCF_t) are used to assess the risk of the investment project as a whole. The greater the deviation value NCF_t from the average expected value, the greater the project risk.

4.1. Analysis

4.1.1. Criteria For Assessing The Significance Of Differences In Outcomes Depending On Exposure To A Risk Factor

Based on Table 2, the most important innovation activities are calculated criteria for

assessing the significance of differences in outcomes depending on the impact of a risk factor and criteria for assessing the strength of the link between the risk factor and the outcome, which are described below.

TABLE 5 CRITERIA FOR ASSESSING THE SIGNIFICANCE OF DIFFERENCES IN OUTCOMES DEPENDING ON EXPOSURE TO A RISK FACTOR

#	Name of the criterion	Criterion value	Significance level
1.	Chi-square test	1.880	0.171
2.	Yates-corrected Chi-square test	1.534	0.216
3.	Likelihood-adjusted Chi-square test	1.884	0.170
4.	Fisher's exact test (two-way)	NaN	p>0,05
5.	*The minimum expected occurrence value is 47.18*		

4.1.2. Criteria for assessing the strength of the link between risk factor and outcome 4.1.3.

TABLE 6 CRITERIA FOR ASSESSING THE STRENGTH OF THE LINK BETWEEN RISK FACTOR AND OUTCOME

#	Name of the criterion	Criterion value	Link Strength*
1.	Criterion φ Criteria *V* Kramer Criteria *To* Chuprova**	0.089	non-essential
2.	Pearson Conjugacy coefficient (C)	0.089	non-essential
3.	Normalized value of the Pearson coefficient (C')	0.126	weak

4. CONCLUSION

Obviously, it is impossible to completely eliminate possible risks; it is necessary to manage risk factors in order to minimize the degree of their influence. Currently, the state, as one of the main participants in the innovation process, is forced to take an active part in the processes of identifying and managing the risks of innovative projects. Successful implementation of innovative projects involves a gradual reduction in the level of risk during the transition from one stage of the project to another. Thus, the risk assessment methods presented in the article make it possible to measure its level at any stage of the innovation cycle. Namely, at the stages of knowledge generation and research and development work, it is advisable to use the proposed method for assessing qualitative risk factors under non-statistical uncertainty. To assess the level of risk at the pre-sowing and sowing stages, the most effective method will be to use the method of assessing qualitative risk factors under conditions of statistical uncertainty. And the last, proposed risk assessment methods can be used in the development of measures aimed at reducing the degree of uncertainty and riskiness of the implementation of innovative projects to a level acceptable to potential investors.

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