THE DEVELOPMENT OF THE RISK MANAGEMENT MECHANISM FOR INNOVATION PROJECT

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Abstract

It is established that the high probability of emergence of risk situations in the innovation project, requires the implementation of risk management measures. It is noted that there is currently no mechanism for distributing of financial risks between the customer and the executor of the innovation project, that is largely negatively reflected in the desire to invest own funds in innovation. The methodological bases of risk management of innovative activity of the project-oriented organization are offered in the article. With the proposed approach, it is possible to estimate in advance how much the proposed risk management measures can reduce the risk of an innovation project and how this activity will affect on the project's effectiveness in deciding whether to continue or stop the innovation project research. On the basis of the existing characteristics of the risk measures of the innovation project, it can be concluded that the best indicator of the effectiveness of a certain stage of the innovation project by the results of simulation is net present value of the project. It is better to use the probability of receiving an ineffective result of an innovation project at an appropriate stage for assessing of the risk of the innovation project and the decision to continue or stop the innovation project at a certain stage.

Keywords: project management, innovation project, risk management, innovative activity, project-oriented organization.

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1. Introduction

Taking into account the analysis of innovative activity of developed countries, it should be noted that the overcoming of the false idea of the possibility of doing this by means of mechanical recovery of the necessary levels of state financing of the scientific and technical sphere should become the priority task of forming of innovation model of development in Ukraine. In this case, we can note that there is not practical possibility of accumulation of the necessary amount of funds for the current state of finances now. Today it is possible to see the hopelessness of investing in the renovation of the scientific sphere due to the lack of adequate to the modern market economy network of science, technology and production. A strategic model of economic growth for developed countries consists of the intensive research and development of the innovative technologies, access to the world market and realization of international integration in the field of science and technology.

The Law of Ukraine "About Scientific and Scientific-Technical Activity" clearly states that the government applies financial, credit and tax mechanisms to create economically favorable conditions for the effective implementation of scientific and technical activity in accordance with the legislation of Ukraine and should ensure the budget financing of scientific and technical activity (except for military expenses) in the amount of not less than 1.7 % of Ukraine's GDP. Today, Ukrainian science is funded by the state at a level of less than 0.3 %, and with a view to extra-budgetary financing – 0.6 % [1]. Negative phenomena in the scientific, technical and innovation sphere become irreversible and threaten to the technological and economic security of Ukraine. This situation requires carrying out of the urgent measures from both of the higher authorities of the country and the executive authorities of all levels.

Theoretical basis of innovative development and innovation project management are described in scientific study [2–8]. There is not sufficiently developed the theoretical approach of the modular process of the innovation project. Available methods of innovation management do not allow minimization of the whole number of risks in the process of realizing of innovation projects. This fact allows to state the impossibility of risk situations between participants of such projects considering the interests of stakeholders of innovative activity. The formation of risk management tools in the process of implementing of innovation projects is the aim of this research. At the same time, the following tasks are solved in the article: specification of the definitions of the innovation project and the risk of the innovation project, determination of relationships and distribution of responsibility of all participants in the innovation project, determination of the impact of risk situations on the activity of a project-based organization, development of mechanisms for risk prevention system management of the innovation project.

2. Materials and Methods

The functioning of high-tech enterprises (such as "Zorya"-"Mashproekt", "Antonov", "PIVDENMASH", etc.) is relatively positive experience. Research units are part of the structure of these enterprises that carry out research in the relevant field. However, the number of such enterprises in Ukraine is measured by units and they can not cardinally change the situation. It is possible to confidently state that financing of scientific sphere is carried out in an inefficient scheme after analyzing of the directions of the state policy in the field of scientific activity. The state does not finance the results of innovation, but it directs money to support of inefficient research institutes and "meager" wages of their employees. In this case there is a situation of uninteresting scholars in the further implementation of the results of their research, so their reports on research work remain in paper form. It is necessary to change the concept of financing of innovation, following to the project management of innovation activity and combining in the same project the whole range of works from the development of the idea to the implementation of innovative products, even if this project is engaged in various specialized organizations [9]. Further as an innovation project let's understand the multi-project with the aim of obtaining of a socio-economic effect from the implementation of the results of innovation activity. For a customer of scientific developments the process of innovation research is not the very substantially but it is important to get the product of the project, obtaining a real result.

The project product should be marketable [10]. This implies a positive effect from the performance of innovation in the form of profit or social benefits.

The use of the concept of a multi-project is justified by the presence in its composition of a complex of stages within the framework of innovation project executed by different organizations, but all of them should have the aim of a single goal (**Fig. 1**). The high level of risk at the stage of initiation of the project is the main feature of innovation projects due to the fact that the positive result of scientific research is not guaranteed. That is why the contract for conducting of scientific works has a stage character allows stopping of the research at a time when the continuation of works becomes inappropriate. However, the organization carrying out the research is not interested in early termination of work and the whole risk lies on the customer of scientific research. Currently, there is no mechanism for distributing of financial risks between the customer and the executor of the innovation project. This fact is largely negatively reflected on the desire to invest own funds in innovation [11].

In accordance with the international standard ISO 31000, the risk is the effect of uncertainty on the target [12]. Based on the definition of an innovation project with the aim of obtaining of the final result, let's accept as a function of the aim the objective parameter NPV – net present value earned from the sale of products created by the innovation project.

The implementation of simulation is the important stage using of the computer program "Statistica" realized by the algorithm of Monte-Carlo. The stated algorithm is repeated n times. The simulation results (NPV of the project) are thus calculated and stored for each simulation experiment.

For graphical analysis it is necessary to construct selective analogues of the distribution function and the density distribution function of the resulting indicator. So, we have to build a risk profile. At first, let's build a histogram of NPV. On the received sample of NPV let's make a variation series, values of NPV are ranked from minimum to maximum. If a person tends to risk, he will soon continue to invest in an innovation project, moving to the next stage of the research with a relatively high average of NPV, paying less attention to its possible risk (a large spread to the average, a significant likelihood of implementing of an ineffective stage of the innovation project). If the executor does not tend to risk, he will most likely stop the research and the financing of the innovation project, or will try to choose a low-risk solution with a small average of NPV. If NPV is positive even in the worst case from the point of view of the decision maker, the innovation project will be continued. If NPV is negative and, even at best, from the point of view of the decision maker the probability of implementing of an effective innovation project is zero, the project should be stopped. So the future state of the innovation project depends on the risk tendency of the decision maker continue the innovation project or stop the research at a certain stage.

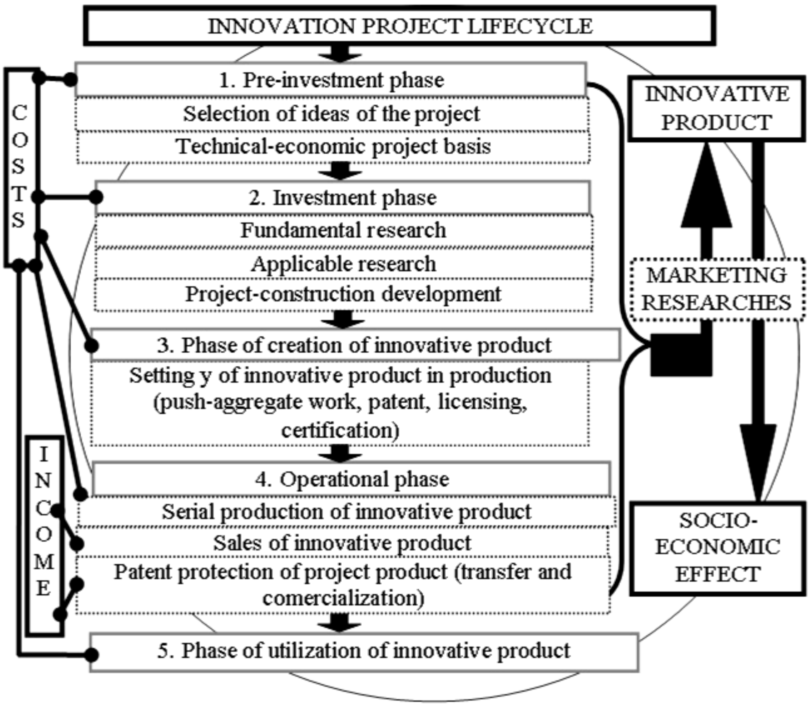

Fig. 1. Stages of Innovation Project

While making the final decision on innovation project, it is necessary to pay special attention not only to the stage where the maximum NPV is obtained. It should also take into account NPV from the beginning of the research, when this level is negative, the result is still not profitable and requires costs only. At some stage of innovation planning, when there is a probability of a risk situation, project participants must make a decision to stop the implementation of research, development and termination of funding.

3. Experimental procedures

Graphically, this process can be displayed as follows (**Fig. 2**). We take the initial risk value for F. At the time of T_1 of implementation of phase FA of the technical task for innovation project, it was established that the risk situation negatively affects the process of carrying out scientific developments with possible financial losses. Participants of the innovation project decide to stop the project at the point of bifurcation A, followed by taking urgent steps to minimize the risk from the value of G to the value of H.

For example, this may be a scientific experiment. If these actions meet the financial point of view of both project participants – the executor and the customer, then the innovation project continues in the BC stage until a new risk situation occurs at the time T_2 that is overcome by the above-mentioned method.

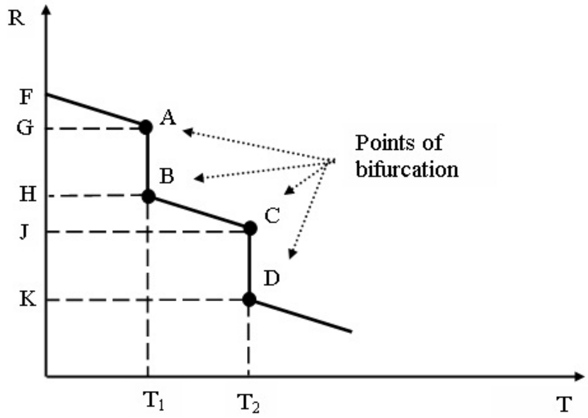

Fig. 2. Dynamics of risk of innovation project

At the time of the achievement of the bifurcation point, fundamental changes in the activity of a knowledge-intensive enterprise must be made. This situation is a characteristic of innovation activity and causes the instability of its state. This unstable state has the prospect of upgrading of the system, and the bifurcation point seems to be a branch of the further development. Possibilities of development are determined by the ratio of two opposite trends. On the one hand, resource flows and random fluctuations provoke an increase in the entropy of the system, that leads to an increase of chaos and, ultimately, can lead to its destruction (negative effects of high innovation risk) [13]. On the other hand, the system seeks to maintain resilience through restructuring and the formation of a new order at the expense of possible positive effects of high innovation risk.

Innovation projects should be divided into stages not in accordance with the calendar plan for the development. The stage of the project must be formed from the results obtained at a definite bifurcation point. This fact will allow the decision to exit the project to determine the negative result or continuation of the project with recalculation and adjustment of the result on the basis of simulation modeling.

To estimate the expediency of continuing of the innovation project, the expected NPV is calculated due to [14]:

$$EV = \sum_{i=1}^{n} (NPV_i * p_i) = \frac{1}{n} * \sum_{i=1}^{n} NPV_i. \quad (1)$$

In order to decide on the expediency of continuing of innovation project, it should be calculated the expected winnings:

$$EG = \sum_{i=1}^{m} (NPV_i^+ * p_i) = \frac{1}{n} * \sum_{i=1}^{m} NPV_i^+, \quad (2)$$

where NPV^+ – positive NPV; m – number of positive NPV in sample of random scenarios.

The calculation of the expected loss rate is another important stage of simulation:

$$EL = \sum_{i=1}^{k} (NPV_i^- * p_i) = \frac{1}{n} * \sum_{i=1}^{k} NPV_i^-, \quad (3)$$

where NPV^- – negative NPV; k – number of negative NPV in sample of random scenarios.

Consequently, the expected NPV of the innovation project is determined as follows [14]:

$$EV = EG + EL. \quad (4)$$

To assess the effectiveness of an innovation project, the normalized expected loss or expected loss ratio should be calculated as:

$$ELR = \frac{|EL|}{EG + |EL|}. \quad (5)$$

The expected loss ratio may vary from 0 (the absence of expected losses and the low risk profile of a certain stage of the innovation project) to 1 (the absence of expected winnings and full risk of the continuation of the innovation project). It is important to determine the coefficient of variation while make a decision of the continuation of innovation project:

$$Var = \frac{\sigma}{EV} = \frac{\sqrt{\sum_{i=1}^{n}\left(\left(NPV_i - \left(\sum_{i=1}^{n} NPV_i * p_i\right)\right)^2 * p_i\right)}}{\sum_{i=1}^{n} NPV_i * p_i} = \frac{\sqrt{n * \sum_{i=1}^{n}\left(NPV_i - EV\right)^2}}{\sum_{i=1}^{n} NPV_i}. \quad (6)$$

The probability of receiving an ineffective result at the appropriate stage of an innovation project is calculated as follows:

$$P(NPV < 0) = \frac{k}{n}, \quad (7)$$

where n – total number of simulated experiments.

4. Results

The probability of project P' implementation with the value of the criterion lower than the marginal level shows the relative frequency of ineffective outcomes at a certain stage of the innovation project and serves as a relative risk measure primarily from the standpoint of individual participants in an innovation project that choose their criterion of interest (R_{criter}) and establish a minimum acceptable value (R_{criter}') for further decision on the possibility of continuation of the project and the transition to the next stage or the suspension of scientific research:

$$P'\left(R_{criter} < R_{criter}'\right) = \frac{g}{n}, \quad (8)$$

where g – number of simulation experiments with a criterion value lower than the limit level $\left(R_{criter} < R_{criter}'\right)$, established by the person who evaluates the risk and makes decisions on the continuation or suspension of the relevant stage of the innovation project. This indicator interprets the risk as a possibility of losses and can be used as a risk indicator when calculating the effectiveness of the continuation of an innovation project.

It should be noted that this indicator figuring out how many times the condition of efficiency was violated, does not indicate how much the loss takes place. This approach evaluates the “dangerous” risk of project, it considers the risk in terms of the possibility of losses that may arise from the decision. Over time, profit is decreasing, and probability of a risk situation also decreases.

The developed conceptual approach of identifying of risk situations in carrying out of innovation activity taking into account the peculiarities of the life cycle of the innovation project (**Table 1**) allowed to develop methodological bases of decision-making in the process of project-oriented management of innovation activity taking into account risk management mechanisms.

In order to identify areas of innovation activity to implement a rational concentration of resources to prevent the emergence of risk situations in innovation project, we will introduce a rank system for evaluating the criteria.

There is a classification of countermeasures (warnings) for risk situations: "Cancel" – refusal to extend a certain stage of innovation project; "Go & Insure" – continuation of innovation project, transition to the next stage, risk insurance; "Go & Do" – continuation of innovation project, in case of necessity to make insignificant changes.

Table 1

Classification model of risk situation distribution according to life cycle stages of innovation project

No.		FR	ER	PDR	PCIP	OP	PPPU
1	Risk of investment attractiveness of an innovation project, R^{INV}	Significant	Significant	Significant	Significant	Insignificant	Medium
2	Risk of lack of necessary resources for innovation project, R^{RES}	Significant	Significant	Significant	Significant	Insignificant	Insignificant
3	Risk of non-fulfillment of contractual conditions between the participants of the innovation project by terms and quality of performance of innovation activity, R^{CONTR}	Significant	Significant	Significant	Significant	Significant	Significant
4	Scientific and technical risks, R^{NTR}	Significant	Significant	Significant	Medium	Insignificant	Insignificant
5	Risk of deviation in terms of implementation stages of the innovation project, R^{TERM}	Significant	Significant	Significant	Significant	Medium	Insignificant
6	Risk of deviation of parameters of project and development research, R^{DEV}	Insignificant	Insignificant	Significant	Significant	Medium	Medium
7	Risk of non-staff requirements innovation project, R^{PERS}	Significant	Significant	Significant	Medium	Medium	Insignificant
8	Negative results of innovation activity (obtaining noncompetitive innovative product), R^{NOT}	Medium	Medium	Significant	Significant	Significant	Insignificant
9	Risk of inconsistency of the technical level of production with the technical level of the innovative product, R^{TECH}	Insignificant	Insignificant	Significant	Significant	Insignificant	Insignificant
10	Risk of legal provision of an innovation project, R^{LAW}	Insignificant	Insignificant	Insignificant	Medium	Significant	Medium
11	Risk of patent protection, R^{PAT}	Insignificant	Insignificant	Insignificant	Significant	Significant	Insignificant
12	Risk of expiration of a license or certificate for the manufacture and use of an innovative product, R^{LIC}	Insignificant	Insignificant	Insignificant	Significant	Significant	Medium
13	Risk of loss of already developed technical solutions, R^{LOST}	Insignificant	Insignificant	Medium	Significant	Significant	Insignificant
14	Risk of competition in new technologies, R^{KON}	Insignificant	Insignificant	Insignificant	Medium	Significant	Insignificant
15	Environmental risk, R^{EC}	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Significant
16	Marketing risk, R^{MAR}	Insignificant	Insignificant	Insignificant	Insignificant	Medium	Significant

Note: [grey] – Insignificant influence; [green] – Medium influence; [blue] – Significant influence; FD – fundamental research; ED – engineering research; PDR – project and development research; PCIP – phase of creation of an innovative product; OP – operational phase; PPPU – phase of project product utilization

The distribution depends on the degree of damage inflicted on the participants in the innovation activity. The severity of the consequences is determined as follows. Significant influence involves the probability of occurrence of losses in case of non-completion of the innovation project (a certain stage of the project), as a result an innovative product will not be obtained, or an innovative product is uncompetitive (with full financing, significant losses). Medium influence assumes that the received innovative product has not paid off in full (the expenses for innovation project are compensated by insurance payments). Insignificant influence comes from the possibility of insignificant losses compensated by the income from the sale of an innovative product. These stages also allow to construct a risk matrix (**Table 2**). To obtain the field of innovation risk let's use the coordinate axes: x – the values of participants exposed to risks in innovation project; y – the essential characteristics of risks; z – sources of risks.

Table 2
Risk matrix for innovation project

Qualitative characteristic of the frequency of the event	Frequency of occurrence of event	The severity of the consequences		
		Significant influence	Medium influence	Insignificant influence
Frequent	>1	Cancel	Cancel	Go&Insure
Probable	$1–10^{-1}$	Cancel	Cancel	Go&Insure
Random	$10^{-1}–10^{-2}$	Cancel	Go&Insure	Go&Do
Unlikely probable	$10^{-2}–10^{-4}$	Cancel	Go&Insure	Go&Do
Implausible	$10^{-4}–10^{-6}$	Go&Insure	Go&Do	Go&Do
Improbable	$<10^{-6}$	Go&Insure	Go&Do	Go&Do

It is necessary to sum up the probability of emergence of risk situations of innovation project, taking into account the frequency of their occurrence λ_i by the formula:

$$R(x,y,z)=\sum_{i=1}^{n}\begin{pmatrix} P_i^{INV}(x,y,z)+P_i^{RES}(x,y,z)+P_i^{CONTR}(x,y,z)+P_i^{NTR}(x,y,z)+ \\ +P_i^{TERM}(x,y,z)+P_i^{DEV}(x,y,z)+P_i^{PERS}(x,y,z)+P_i^{NOT}(x,y,z)+ \\ +P_i^{TECH}(x,y,z)+P_i^{LAW}(x,y,z)+P_i^{PAT}(x,y,z)+P_i^{LIC}(x,y,z)+ \\ +P_i^{LOST}(x,y,z)+P_i^{KON}(x,y,z)+P_i^{EC}(x,y,z)+P_i^{MAR}(x,y,z) \end{pmatrix}\lambda_i. \quad (15)$$

By combining of different risk characteristics for each of the following three indicators, a classification model for risk management in the performance of innovation activity can be constructed (**Fig. 3**).

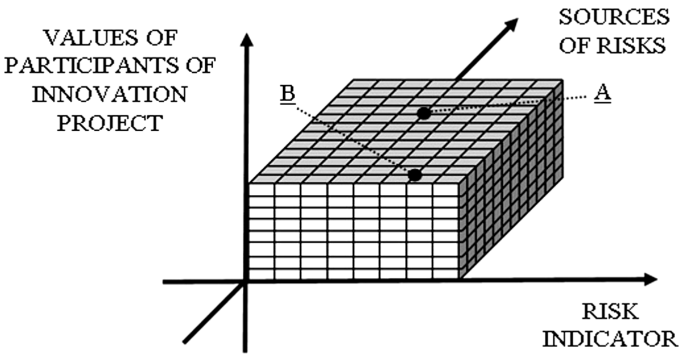

Fig. 3. Classification model of risk-oriented approach in innovation project

Here is an example of description of situations, based on the classification. The variant of the description of the risk situation for point A with coordinates (X_4; Y_4; Z_8) is as follows: failures in the work of the technological subsystem of the innovation project, the elimination of which may require financial resources and may have negative effects on the sales of the innovative product.

In the technological subsystem, the source of the failure may be state of equipment (for example, during a scientific experiment), and in its repair or replacement may be required funds that will eventually ruin the term of development of an innovative product. Option for describing the risk of innovation project at point B with coordinates (X_6; Y_3; Z_1) is the risk of a loss of market position caused by surface marketing when developed innovative product is uncompetitive.

5. Discussion

There were spent a lot of efforts on development of the reform of innovation infrastructure for advanced technology in recent years, but, as the realities show, its performance is not very large. The combination of science and production has its advantages – science feels the needs of production, they have common goals.

However, it is not profitable in the state of the production enterprise to hold academics, professors, who would carry out innovative research. The effectiveness of such cooperation will be much lower than in the implementation of developments in specialized research institutes. From this follows the expediency of distributing the participants of the innovation project to groups of scientists, producers, marketers, etc., working in different organizations to achieve a single goal. If you make this stage, you need to learn how to share responsibility for emerging of risk situations among all participants in such interaction. After all, at the initial stage of project a scientist will receive funding, but he does not guarantee the result and does not bear the risk of failure of the project. It is proposed to provide partial financing at the initial stage and further cash flow, having received the real competitive result of innovation project while selling of the project product. In this situation, the risk will be managed by each participant as part of his responsibility for a particular stage. With this approach, the probability of obtaining of a negative NPV is reduced at several times, approaching zero.

There are some disadvantages in the above-mentioned approach to risk management in innovation project associated with the appearance of other risks of a particular innovative product that we could not include in the presented classification model. In addition, the expected effect of the implementation of multi-projects is not influenced by the level of risk only, but also by the degree of prevention of possible losses limited by the financial capabilities of the organization carrying out of risk insurance. The obtained research results can be used in the future for development of the mechanisms of the formation of the program and portfolio of innovation projects, that will offer to increase the effectiveness of the interaction of organizations within the triple spiral model "university-business-state".

6. Conclusions

The proposed high-tech directions are separated from the actual selection and financing of priority projects in the country. The selection of projects for potential implementation is carried out by scientific and industrial experts, and their actual implementation depends on investors, banks, financial development institutions, their criteria is mot the same with the selection criteria of projects.

Therefore, from the random selection of projects for implementation, it is necessary to move to a conscious long-term national industrial policy. Based on the existing characteristics of the risk measurers of the innovation project, it can be concluded that the best indicator of the evaluation of the effectiveness of a certain stage of the innovation project by the results of the Monte Carlo simulation model is the expected NPV, and for assessing of the risk of the innovation project and the decision to continue or stop the innovation project at a certain stage it is better to use the probability of receiving an ineffective result of the innovation project at the appropriate stage and the coefficient of expected losses.

High probability of emergence of risk situations in the innovation project requires the implementation of risk management measures. Using the proposed approach, it is possible to estimate in advance how the risk management measures can reduce the risk of an innovation project and how this deal will affect to the project effectiveness in deciding whether to continue or stop the innovation project research.

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