Management of Enterprise Innovation Costs to Ensure Economic Security

Svitlana Bondarenko, Liudmyla Verbivska, Natalia Dobrianska, Ganna Iefimova, Valentyna Pavlova, Oksana Mamrotska

Abstract: ***Innovative activity has always been a sphere of economic activity with a difficultly predicted ratio of costs to the resulting economic effect. The size of the costs of implementing innovative activities is often determined by many factors and the effective management of these costs determines the economic success of the organization.***

The volume of expendable resources is one of the most important indicators of the effectiveness of any enterprise, and the expenditure of money on innovative activities is also the basis of economic security of any organization. The effectiveness of cost management is determined by how little resources have been used up and how much effect has been achieved. Uncontrolled spending of resources, and senseless spending on the modernization of the entire range of products can lead to the collapse of even the most successful innovative enterprise.

The economic security of any organization associated with innovation is primarily dependent on the effective management of the costs of implementing this innovation.

Keywords **: *innovation costs, economic security, enterprise, management.***

I. INTRODUCTION

The volume of expendable resources is one of the most important indicators of the effectiveness of any enterprise, and the expenditure of money on innovative activities is also the basis of economic security of any organization. The effectiveness of cost management is determined by how little resources have been used up and how much effect has been achieved [1-4].

Why is the issue of the impact of innovation cost management on economic security so important? Innovative activity, this is something akin to the two-faced god Janus, on the one hand, it can provide attractive opportunities for achieving excess profits, on the other hand, it can lead to financial collapse [5-7].

It is undeniable that single enthusiasts are able to make a revolutionary scientific breakthrough and create the basis for a future economic miracle in the backyard garage, but this is rather an exception to the rule [8-9]. And the rule says that only effective cost management for innovation, can protect the company from financial collapse.

The management of innovative costs implies an integrated approach, it should be noted that several factors, schematically presented in (Fig.1), affect the amount of costs during the implementation of an innovative project:

1. The scale of the innovation project - this can be a project that aims to modernize existing technology or it can be a whole range of measures to create a new revolutionary product using advanced technologies and materials [10]. Accordingly, the project itself can be implemented as a small team of specialists, and it is possible for its implementation it will be necessary to attract a number of subcontractors, and therefore the amount of expenditure on the project itself can range from insignificant, within the budget of the enterprise, to very serious expenses from using mechanisms of external borrowing.

2. The time factor for the implementation of innovation is the duration of the project itself, because it is possible to carry out short-term projects within a short period of time with easily predictable costs, and a long-term project during which the time frame can change [11]. The duration of the project proportionally affects the accuracy and complexity of forecasting costs in future periods, the growth of the duration contributes to the inclusion in the forecast of such factors as the variability of the external environment, the change of political and economic conditions.

3. The factor of magnitude - this indicator seems most obvious when it comes to the implementation of projects related to product innovation. Increases in the size, capacity of machinery, equipment, and the cost of creating an object usually increase. However, per unit volume, area, capacity, costs are reduced with a simple increase in the size of the object.

4. Innovative activity of the enterprise - the frequency of implementation of innovative activities also significantly affects innovative costs. The more actively the company engages in innovative activities, the more the unit costs for each subsequent operation decreases.

5. Scientific and technical characteristics of the project - this factor determines the nature of the innovative project. The amount of costs for fundamental innovations will be fundamentally different from innovations for upgrading a product or technology. In addition, the cost of innovation to modernize the product can also vary significantly when it comes to which particular characteristics of the product will need to be changed and by what amount.

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6. Change in tariffs, prices and rates for resources necessary for the implementation of innovative activities. The magnitude of the cost of innovation increases in proportion to the increase in inflation and, as a result, the increase in prices of resources used.

7. The level of cost management, which is expressed in the presence of economically and technically determined standards for the consumption of resources, the ability to predict, plan and control costs. Of great importance here are the information component, the availability of modern information technologies.

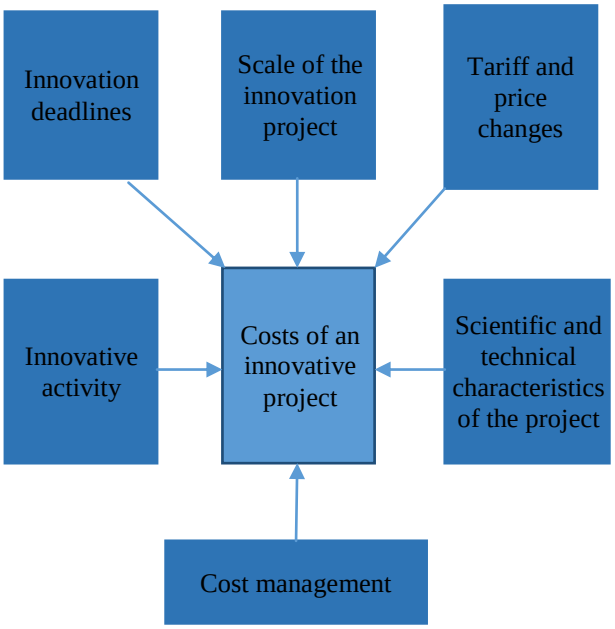

Fig.1 Scheme of factors affecting the size of innovation costs

These factors significantly affect the overall level of innovative costs. In this connection, in order to minimize the negative impact of these factors, organizations should strive to create a well-functioning system for managing innovative activities in general and innovative costs in particular [12-14].

Having determined the size and the cost of implementing specific innovative projects, we can already determine the algorithm for managing them. Actually, cost management itself determines the economic security of innovation. Even the most ambitious innovative project, financed from various sources, and with a significant share of borrowed capital, with proper cost management, is much safer than a small project with inefficient management.

So what exactly does the mechanism of managing innovative costs include? Actually, the control algorithm itself can be represented in several stages:

1. The costs necessary for achieving the planned goals are determined by the places of their occurrence, by type of product, by project, these values are fixed in the planned indicators and standards.

2. “Control points” are established during the transition from one phase of the innovation process to another, as well as within the phases. At these points, actual costs will be recorded and their deviations from planned, normative ones will be revealed.

3. Based on the assessment and analysis of deviations, appropriate management decisions are made. With innovation, in contrast to traditional, it is necessary to change not only the actual costs, but also the standards. Based on the assessment and analysis of deviations, decisions may be made on the premature closure of the project [15].

In an actively developing risky external environment, the use of effective management mechanisms is required, which include, first of all, planning mechanisms in a broad sense, in particular, mechanisms for the formation and economic justification of the choice of innovative projects.

II. MANAGEMENT OF ENTERPRISE INNOVATION COSTS TO ENSURE ECONOMIC SECURITY

For the indicative method of managing innovative costs - we apply the principle of optimal planning - achieving maximum results with limited resources and costs. Although indicative methods are more often used at the macroeconomic level, nevertheless, they can be quite successfully applied when planning costs at the microeconomic level of an enterprise.

The components of the optimal indicative plan are an integer economic and mathematical problem, with the multiplicative form of the objective function, functional dependencies between variables and constraint parameters specified in a tabular form. The optimal solution is based on the dynamic programming method.

The mathematical statement of the problem of optimizing the indicative innovation plan is as follows:

$$N = N_0 \times \prod_{i=1}^{n} J(X_i) \rightarrow max$$

$$\sum_{i=1}^{n} Z(X_i) \leq \bar{Z}$$

$$X_i = 1{,}0 \; i = 1 \ldots n$$

where $J(X_i)$ is the index of indicative planning of the i-th factor;

P is the sign of the work;

X_i is a control variable;

N, N_0 – values of the planned factor in the planned and reporting

period;

$Z(X_i)$ – the planned investment value for the i-th factor,

$\bar{Z}$ is the total limit of investment expenses.

The solution is carried out in several stages (iterations), their number is equal to the number of variables of the problem.

You can interpret the course of the solution as follows - at each step of the solution, the total budget of innovative costs is distributed in stages between existing options for innovative projects. In this case, the maximum value at each step (max (J_i (y)) is considered optimal.

The peculiarity of the chosen solution method is that dynamic programming allows you to sort through all the options for the distribution of resources in the most convenient form and choose the optimal cost distribution to achieve the maximum economic effect.

$$\prod_{i=1}^{n} J_i(y) \to max$$

$$\sum_{i=1}^{n} Z_i(y) \le \bar{Z}$$

$$y = 0,1 \dots \bar{Z}$$

$$i = 1 \dots n$$

The equations describing the course of solving the problem by the dynamic programming method can be represented as follows

$$\varphi_1 = maxJ_i(y)$$

$$0 \le y \le \bar{Z}$$

$$\varphi_i = maxJ_i(y) \times \varphi_{1+1}(\bar{Z} - y)$$

$$0 \le y \le \bar{Z}$$

$$y = 1 \dots \bar{Z}$$

$$i = 1 \dots n$$

The presented method is a three-factor model. Where factors are “scenarios” of the development of the system, including the option of “evolutionary” development, that is, the continuation of the trend, while the implementation of other “scenarios” requires investment.

III. RESULT AND DISCUSSION

As an example of testing the management methodology, data will be used to optimize the management of costs for the implementation of innovative projects of an enterprise manufacturing replaceable parts for industrial robots. An innovative software was provided for the modernization of the existing product range. The proposed projects provided for six options for modernization, each of which was a comprehensive iterative development and implementation project involving re-investment of funds. Each of the projects affects both manufacturing technology, and the materials used, and the final characteristics of the products. Each of the projects was independent of the others, as it provided for separate segments of the general assortment of products manufactured on separate production lines. The development strategy of the company implied the implementation of only three projects, since the selection of all of them implied the emergence of risks with both cost overruns and risks violating existing supply contracts. A direct threat to the financial security of the company was more than obvious, the rejection of the implementation of innovative projects promised a loss of market positions in the future, and the implementation of an excessive number of projects could lead to a loss of financial independence.

Each project (Tab.1) was characterized by the need for capital investments (Δ) and the provided increase in sales (Z (Δ)), as well as the value of the profitability indicator. The general limit of funds (lim) for the implementation of the program has also been set.

Table- I: Options for investment projects on innovation enterprise

Name of the project	Capital attachments (Δ)	Growth sales (Z (Δ))	Profitability sales, %
Project #1	20	240	8
Project #2	15	180	5
Project #3	35	380	4
Project #4	30	310	6
Project #5	25	280	4
Project #6	40	450	5
Total limit capital attachment (lim)	70		

Real capital investments represent a number of investment projects. Projects can only be implemented in full, can either be included in the investment plan or not. Thus, the company is interested, within the existing limit, to choose for implementation those projects that will provide the largest increase in sales in the planning period.

It is proposed to solve this problem by the method of dynamic programming. At all steps of the formation of the program, individual projects and the corresponding sales volumes are included in it. The resource limit is sequentially distributed between one, two and, at the last step, the entire set of projects.

$$step\ 1.\ \varphi_1(\Delta) = maxZ_1(\Delta), 0 \le \Delta \le \bar{\Delta}$$

$$step\ 2.\ \varphi_2(\Delta) = \min[Z_2(\Delta) + \varphi_1(\Delta - \bar{\Delta})], 0 \le \Delta \le \bar{\Delta},, 0 \le x \le A$$

……

$$step\ n.\ \varphi_n(X) = \max[3_n(y) + \varphi_{n-1}(x - y)], 0 \le y \le x,, 0 \le x \le A$$

where Δ is the capital cost of each step, φ_ (n-1) is the optimal sale of the previous step.

As can be seen from Tab. 2 in this case, the maximum increase in revenue when investing:

$$2\ times * Project\ 1 + 2\ times * Project\ 2 = 840\ thousand\ US\ dollars.$$

Table- II: The first step in solving the optimization problem of managing innovative costs

		Project #2							
		0	10	20	30	40	50	60	70
Project #1	0	0	0	180	360	360	540	720	720
	10	0	0	180	360	360	540	720	-
	20	240	240	420	600	600	780	-	-
	30	240	240	420	600	60	-	-	-
	40	480	480	660	**840**	-	-	-	-
	50	80	480	-	-	-	-	-	-
	60	20	720	-	-	-	-	-	-
	70	20	-	-	-	-	-	-	-
	Sales		0	240	360	480	600	720	840
	What project are we investing in		-	1	2i*2	2i*1	3p1	4i*1	2i*1 + 2i*2

We will carry out the following iterations of calculations, the results of which will be displayed in (tab.3-6) at all stages, the maximum increase in revenue when investing:

$$2\ times\ *\ Project\ 1\ +\ 2\ times\ *\ Project\ 2\ =\ 840\ thousand\ US\ dollars.$$

Table- III: The second step in solving the optimization problem of managing innovative costs

		Project #3							
		0	**10**	**20**	**30**	**40**	**50**	**60**	**70**
Project #1+2	**0**	**0**	**0**	**0**	**0**	**380**	**380**	**380**	**760**
	10	**0**	**0**	**0**	**0**	**380**	**380**	**380**	**-**
	20	**240**	**240**	**240**	**240**	**620**	**620**	**-**	**-**
	30	**360**	**360**	**360**	**360**	**740**	**-**	**-**	**-**
	40	**480**	**480**	**480**	**480**	**-**	**-**	**-**	**-**
	50	**600**	**600**	**600**	**-**	**-**	**-**	**-**	**-**
	60	**720**	**720**	**-**	**-**	**-**	**-**	**-**	**-**
	70	**840**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Sales	**0**	**0**	**240**	**360**	**480**	**600**	**720**	**840**

Table- IV: The third step in solving the optimization problem of managing innovative costs

		Project #4							
		0	10	20	30	40	50	60	70
Project #1+2+3	0	0	0	0	310	310	310	620	620
	10	0	0	0	310	310	310	620	-
	20	240	240	240	550	550	550	-	-
	30	360	360	360	670	670	-	-	-
	40	480	480	480	790	-	-	-	-
	50	600	600	600	-	-	-	-	-
	60	720	720	-	-	-	-	-	-
	70	**840**	-	-	-	-	-	-	-
	Sales	0	0	240	360	480	600	720	840

Table- V: The fourth step in solving the optimization problem of managing innovative costs

		Project #5							
		0	10	20	30	40	50	60	70
Project #1+2+3+4	0	0	0	0	280	280	560	560	560
	10	0	0	0	280	280	560	560	-
	20	240	240	240	520	520	800	-	-
	30	360	360	360	640	640	-	-	-
	40	480	480	480	760	-	-	-	-
	50	600	600	600	-	-	-	-	-
	60	720	720	-	-	-	-	-	-
	70	**840**	-	-	-	-	-	-	-
	Sales	0	0	240	360	480	600	720	840

Table- VI: The final step in solving the optimization problem of managing innovative costs

		Project #6							
		0	10	20	30	40	50	60	70
Project #1+2+3+4+5	0	0	0	0	0	450	450	450	450
	10	0	0	0	0	450	450	450	-
	20	240	240	240	240	690	690	-	-
	30	240	360	360	240	810	-	-	-
	40	480	480	480	480	-	-	-	-
	50	600	600	600	-	-	-	-	-
	60	720	720	-	-	-	-	-	-
	70	**840**	-	-	-	-	-	-	-
	Sales	0	0	240	360	480	600	720	840

IV. CONCLUSION

Since different combinations of projects give the same maximum revenue increase of $ 840 thousand, thus, we can conclude that the maximum increase in profit from sales will be obtained thanks to the first and second projects.

The presented methodology is a three-factor model. Where factors are “scenarios” of the development of the innovation system in the planning period, including the variant of “evolutionary” development, that is, a continuation of the already existing trend in the period preceding the planned one. If “evolutionary” development is realized without additional investment costs, then the implementation of other “scenarios” requires investment in the innovation system. As shown, a similar problem can be successfully solved by the proposed method.

The ability to predetermine the expenditure of innovative costs, and effectively manage them, allows any modern enterprise to consolidate its economic security.

REFERENCES

1. B. Danylyshyn, S. Bondarenko, M. Malanchuk, K. Kucherenko, V. Pylypiv, O. Usachenko. Method of Real Options in Managing Investment Projects, *International Journal of Innovative Technology and Exploring Engineering*, Volume-8 Issue-10, August 2019, pp. 2696-2699
2. D. A. Ignatov, Legal models of ensuring economic security, Jan 2017, DOI: 10.20310/1819-8813-2017-12-2-190-194
3. Bondarenko, S., Liliya, B., Oksana, K., Inna, G., Modelling instruments in risk management, *International Journal of Civil Engineering and Technology*, 10(1), 2019, pp. 1561-1568
4. Prokopenko, O., Kysly, V., Shevchenko, H., Peculiarities of the natural resources economic estimation under the transformational conditions, Economic Annals-XXI, 2014, 7-8, pp. 40-43
5. Bashynska I., O. Sokhatska, T. Stepanova, M. Malanchuk, S. Rybianets, O. Sobol, Modeling the risks of international trade contracts, *International Journal of Innovative Technology and Exploring Engineering*, Volume-8 Issue-11, Sep. 2019, pp. 2815-2820
6. Ivan Vadimovich Kochikin, Stanislav Buyanskiy, Ensuring Economic Security in Lending Sphere, Jun 2016, DOI: 10.15688/jvolsu3.2016.2.9
7. I. Bashynska, M. Baldzhy. L. Ivanchenkova, L. Skliar, O. Nikoliuk, G. Tkachuk, Game Risk Management Methods for Investment Portfolio Optimization, *International Journal of Recent Technology and Engineering*, Volume-8 Issue-2, 2019, pp. 3940-3943 DOI: 10.35940/ijrte.B1729.078219.
8. Natalya Kulagina, Innovative development in the conditions of ensuring economic security of the region, April 2017, DOI: 10.12737/article_58f9c4d9b9a380.88811593
9. V. V. Sopko, O. M. Romashko, Controlling as a means of ensuring economic security at an enterprise, Actual Problems of Economics, January 2012, pp. 176-180
10. A. Stavytskyy, The Role of European Integration in Ensuring Economic Security, May 2019, DOI: 10.17721/1728-2667.2019/203-2/7
11. M. B. Sultygova, Formation of the plan events on ensuring economic security companies based project approach, June 2018, DOI: 10.21869/2223-1560-2018-22-3-103-112
12. H. Tkachuk, Modern trends in agriculture development in the context of ensuring economic security, April 2019, DOI: 10.26642/jen-2019-1(87)-42-47
13. Andrii Kubaienko, Classification of forms of shadow economic activity from the viewpoint of ensuring economic security, January 2018, DOI: 10.30525/2256-0742/2018-4-1-242-247
14. T.I. Samatov, Methods and indicators of ensuring economic security of an industrial complex of the region, December 2018, DOI: 10.22363/2313-2329-2018-26-1-89-100
15. N.G. Gadzhiev, Organizational and methodical aspects of ensuring economic security of business processes of economic entity, January 2018, DOI: 10.21779/2500-1930-2018-33-3-6-12