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Economic mechanism for decomposition of results of scientific and technical activities

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Economic mechanism for decomposition of results of scientific and technical activities

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Abstract. In the modern conditions of global competition, when the implementation of financial and economic activities by industrial enterprises of real sectors of the economy is impossible without possessing unique key competencies that give undeniable advantages over competitors, not only new forms of doing business lead, which undoubtedly appeared during the general global coronavirus pandemic, COVID-19, when most enterprises were forced to switch to a remote mode of work of labor collectives, and consumption has largely shifted to the e-commerce format, but also the ability to optimize work with the existing resource base, which can be fully attributed to obtained results of scientific and technical activities (RSTA), which are inherently unique and limited resource for external participants in business processes. This paper is aimed at researching project management tools that allow the management of high-tech companies that create and work with RSTA to discover new opportunities provided by a new project management tool: economic mechanism of RSTA decomposition. The article examines modern management methods based on the available resource potential. The methodological aspects of the research are based on solving the multi-criteria problem of project management, covering the practical area of research activities carried out by high-tech companies.

1. Introduction

One of the tools for making effective decisions that allows the choice of the optimal solution in the presence of many alternatives is work with the existing resource base of the enterprise.

Since the foundation of the resource base of any enterprise is formed by assets transferred by its founders, as well as created in the process of carrying out economic activities, which form the fundamental economic foundations on which the vital activity of the enterprise in general is built, they cannot be considered one-sidedly as an element of distribution, first of all they have an institutional importance associated with the achievement of the set strategic goals, implementation of socio-economic missions and possibility of using intellectual capital [1].

The use of intellectual capital in the form of RSTA as a resource base will allow the enterprise to provide strategic competitive advantages, and in addition, with a skillful organization of the effective administration process, receive superprofits in the market; constantly monitor the cost of manufactured products, implementing fundamentally new scenario approaches to cost optimization.

The purpose of this work is to study the possibilities of obtaining the optimal choice when working with RSTA using the economic decomposition mechanism, which provides conditions for the effective recovery of previously obtained results in the framework of R&D.

The fundamental task when using RSTA as the resource base of the enterprise is to maximize profits by optimizing previously incurred costs in the field of R&D work [2].

However, when applying calculations related to the optimization of the costs, there is a certain number of problematic issues related to the production sphere, regulation of technological processes, etc., which determines the distinctive feature of these calculations in the form of a large dimensionality of the available RSTA, from the final sets of which are supposed to be chosen [3].

The current posed problem can be solved, among other things, by the decomposition method, i.e. by analyzing the original problem for a certain number of problems of a lower dimension, followed by finding independent solutions for each of them and further combining these solutions into an integrated solution to the original problem [4].

2. RSTA decomposition algorithm

Formulating the set task in economic terms, we can say that there is a certain number of RSTA, consisting of N elements, each of them is a complete result of a certain type, but, at the same time, all of them are obtained in the process of performing R&D, interconnected according to the strategic and tactical goals of the production activity of the enterprise.

The presented description of the problem has the following mathematical model:

$$\sum_{i=1}^{N} C^{(i)}\, X^{(i)} \to max. \tag{1}$$

In this case, the following limitations are introduced:

$$\begin{cases} A^{(1)}X^{(1)} + A^{(2)}X^{(2)} + \ldots + A^{(N)}X^{(N)} \le B \\ \tilde{A}^{(i)}X^{(i)} \le \tilde{B}^{(i)} \qquad (i = \overline{1,N}) \\ X^{(i)} \ge 0 \qquad (i = \overline{1,N}) \end{cases} . \tag{2}$$

Here i is the index of the element included in the system$(i = \overline{1,N})$;
$\tilde{A}^{(i)}$ is the matrix of coefficients (norms) of the costs of local resources for obtaining an element by the i-th RSTA;
$A^{(i)}$ is the matrix of coefficients (norms) of the costs of general resources for product output;
$\tilde{B}^{(i)}$ is the amount of available resources;
B is the amount of common resources;
$C^{(i)}$ is the vector of specific profit;
$X^{(i)}$ is the vector of production output.

Let be $D^{(i)} = \{X^{(i)} \in R_{m(i)} : \tilde{A}^{(i)}X^{(i)} = \tilde{b}^{(i)},\ X^{(i)} \ge 0 \quad (i = \overline{1,N})\}$, it is the convex closed bounded set. $X_j^{(i)}$ are the vertices of this set$\left(i = \overline{1,N},\ \ j = \overline{1,k(i)}\right)$. Any point $X^{(i)} \in D^{(i)}$ can be presented as:

$$X^{(i)} = \sum_{j=1}^{k(i)} Y_j^{(i)} X_j^{(i)}, \text{ where } Y_j^{(i)} \ge 0;\ \sum_{j=1}^{k(i)} Y_j^{(i)} = 1.$$

Then problem (1) - (2) will look as the following equation:

$$\sum_{j=1}^{k(1)} C^{(1)}Y_j^{(1)}X_j^{(1)} + \sum_{j=1}^{k(2)} C^{(2)}Y_j^{(2)}X_j^{(2)} + \ldots + \sum_{j=1}^{k(N)} C^{(N)}Y_j^{(N)}X_j^{(N)} \to max, \tag{3}$$

with limitations:

$$\begin{cases} \sum_{j=1}^{k(1)} A^{(1)}Y_j^{(1)}X_j^{(1)} + \ldots + \sum_{j=1}^{k(N)} A^{(N)}Y_j^{(N)}X_j^{(N)} = B \\ \sum_{j=1}^{k(i)} Y_j^{(i)} = 1 \\ Y_j^{(i)} \ge 0 \qquad i = \overline{1,N},\ \ j = \overline{1,k(i)} \end{cases} . \tag{4}$$

We introduce the notation $\delta_j^{(i)} = \langle C^{(i)}, X_j^{(i)} \rangle$, $P_j^{(i)} = \begin{pmatrix} A^{(i)}X_j^{(i)}\}r_0 \\ \left.\begin{matrix} 0 \\ \vdots \\ 0 \\ 1\ \}r(i)+i \\ 0 \\ \vdots \\ 0 \end{matrix}\right\} N \end{pmatrix}$.

Taking into account these notation, from (3) - (4) we pass to:

$$\sum_{j=1}^{k(1)} \delta_j^{(1)} Y_j^{(1)} + \sum_{j=1}^{k(2)} \delta_j^{(2)} Y_j^{(2)} + \ldots + \sum_{j=1}^{k(N)} \delta_j^{(\mathrm{T})} Y_j^{(N)} \to max \tag{5}$$

$$\begin{cases} \sum_{j=1}^{s(1)} P_j^{(1)} Y_j^{(1)} + \sum_{j=1}^{s(2)} P_j^{(2)} Y_j^{(2)} + \ldots + \sum_{j=1}^{s(N)} P_j^{(N)} Y_j^{(N)} = B \\ \sum_{j=1}^{k(i)} Y_j^{(i)} = 1 \\ Y_j^{(i)} \geq 0 \qquad i = \overline{1,N}\,,\ j = \overline{1, s(\imath)} \end{cases} \tag{6}$$

(5)–(6) is the coordinating (main) task.

The optimal solution to the original problem can be found by the following formula:

$$X^{*(i)} = \sum_{j=1}^{k(i)} Y_j^{*(i)} X_j^{*(i)}.$$

Problem (5) - (6) will be solved by the simplex method; to solve this problem, it will be necessary to identify the vectors included in the basis and excluded from it.

The meaning of constructing the main problem when using the decomposition method is that this problem can be solved by having at our disposal only one extreme point from the entire set of vertices corresponding to the input variable.

By defining the vertex, we can define all the elements$\mathrm{P}_j^{(i)}$, and we can also define the grade $\Delta_j^{(i)}$, corresponding to this vector, then the excluded vector is determined by the usual method, taking into account the admissibility conditions of the simplex method [5].

3. Theoretical basis

High-tech companies, in most cases, participate in the implementation of investment projects in the field of R&D, which are often interconnected and their implementation largely determines the financial and economic component of the company [6]. The administration of R&D projects requires the use of various models for optimizing the existing resource base and solving the problem of further choosing an investment strategy. The choice of the optimal option for the given resource constraints affects the total cost of the project and its profitability [7].

An essential condition for solving the posed problem of choosing the optimal option is the development of an economic mechanism for decomposition of RSTA.

The reliability of the results largely depends on the degree of adequacy of the initial technical and economic information to the real conditions of their implementation, methodological validity, algorithmic and regulatory correctness of the calculations.

4. Methodology

The methodological basis of the research was formed by general scientific methods of systems theory, deduction, induction, abstraction, formalization, as well as special methods of economic analysis. In addition, we used the works of both Russian and foreign authors in the field of research and practical application of project management.

5. Results

The economic mechanism of decomposition of RSTA is implemented by means of solving the problem at the lower level for each element of RSTA with subsequent transfer to the upper level of the optimal solution, where the planned result is adjusted as a set of private optima aimed at achieving a single goal.

The proposed methodological approach takes into account the practice of implementing the results obtained in the field of R&D and is focused primarily on the rational use of the available scientific potential and ensuring a reduction in the cost of scientific developments with a consistently high level of added value, expressed in the form of intellectual labor, ultimately transformed into tangible and intangible assets.

The study of the current state of the issue of the development of the topic of the search for the economic mechanism of decomposition of RSTA presupposes the gradual development of scientific and methodological approaches in the field of analysis of the results of R&D in the creation of high-tech products, which are an integral part of the management system tool in the field of project management.

The scientific and methodological aspects of decomposition and subsequent analysis in the field of R&D are based on the need to conduct a comprehensive and critical assessment of the economic effect of the results obtained on the basis of retrospective and prospective studies, the results of which will be the basis for assessing the effectiveness of program and planning documents and rational distribution of the available resource base.

The economic mechanism of R&D decomposition is a continuous process of transferring accumulated knowledge and developed practical technologies that serve as the intellectual and economic basis for the subsequent qualitative change in the scientific and technical landscape. The conditioned processes should not be “closed” within the framework of one R&D theme, but, if necessary, they should be used as a tool for scientific and technical groundwork by interested developers and creators of new samples of high-tech products.

6. Conclusions

The economic mechanism of decomposition of RSTA is based on the use of elements of economic and mathematical modeling, which ensures the selection and adoption of the optimal decision for the subsequent use of RSTA as a resource base, which allows implementing fundamentally new scenario approaches to cost optimization and the subsequent formation of enterprise profits.

Trends in the development of high-tech industries show that in the future, decision-making on further scientific and technological development will face the problem of a critical objective assessment of the results of R&D in a particular area in order to optimally combine the distribution of available resources and created production facilities.

The study of practical experience in the development of high-tech industries in industrially developed countries shows that the active innovative activity of industrial enterprises was determined by serious measures of state support for initiatives emanating not only from large corporations, but also from multifunctional industrial enterprises specializing in individual projects in the innovation sphere and together forming the basis of industrial the potential of a particular industry.

Priority measures of state policy presuppose, first of all, the removal of barriers and the creation of the most comfortable conditions for all business entities working in the field of R&D activities aimed at achieving breakthrough, qualitatively new results of scientific and technical activities, ahead of the existing level of technical and technological development, as well as the creation of industries that contribute to a qualitative transition to a new level of technological order.

The rational use of the resource potential in the form of the results of scientific and technical activities is a poorly studied topic in the context of creating a post-industrial economy based on the use of the achievements of scientific progress.

Research in this area involves the coverage of scientific and methodological foundations and approaches to the formation and subsequent disclosure of the provisions describing the tools for the economic reproduction of competitive products with high added value.

In the current conditions, the search for a mechanism for the effective reproduction of scientific and technological knowledge, as the basis for the competitiveness of high-tech industries, is one of the urgent tasks for the further development of the economy as a whole.

Summing up, it should be noted that a qualitative study of the foundations of the mechanism of the institution of economic decomposition of RSTA in high-tech industries will contribute not only to ensuring the development of a policy for maintaining priority scientific and technological areas of knowledge, but also to creating a reliable tool for the formation of synergetic effects in the development of innovative products.

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