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FORMING A METHODOLOGICAL APPROACH TO THE MANAGEMENT SYSTEM OF INNOVATIVE ACTIVITIES AT ENTERPRISES IN CONDITIONS OF ECONOMIC DEVELOPMENT

Vladimir PANCHENKO[1*], Roksolana IVANOVA[2], Olha VIUNYK[3], Ilona ANDROSHCHUK[3], Olga GUK[4]

[1]*Department of Pedagogy and Management of Education, Volodymyr Vynnychenko Central Ukrainian State Pedagogical University, Kropyvnytskyi, Ukraine*
[2]*Department of International and European Law, Leonid Yuzkov Khmelnytskyi University of Management and Law, Khmelnytskyi, Ukraine*
[3]*Department of Economy, Management and Commercial Activity, Central Ukrainian National Technical University, Kropyvnytskyi, Ukraine*
[4]*Department of Management of Enterprises, National Technical University of Ukraine "Igor Sikorsky Kiev Polytechnic Institute", Kyiv, Ukraine*

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Abstract. The main purpose of the study is to form a methodological approach to the management system of innovative activities at enterprises in the context of their economic development. To achieve this purpose, a methodical approach was formed containing a certain set of methods, the main of which is the methodology of functional modeling and graphic representation – IDEF0. As a result, the main decompositions of our model were presented with the proposed ways to improve the management system of innovative activities at the enterprise, taking into account the main goals of economic development. Our study was presented in the work of several companies in Eastern Europe to identify its effectiveness and convenience. The flexibility of the model makes it possible to effectively apply it in the practical activities of many enterprises. The originality of the research results implies the application of the existing methodology in a new area for it, namely in the management system of innovative activities and innovative development of the enterprise. The study has several limitations, which are primarily related to the fact that, due to the conditions of the pandemic, its practical application took place exclusively at Ukrainian enterprises.

Keywords: management, innovative activities, enterprises, economic development, modeling, economy.

JEL Classification: O12, O31.

*Corresponding author. E-mail: *panchenko.vladimir.edu@gmail.com*

Introduction

In modern market conditions and the strengthening of competitiveness, innovations are becoming increasingly important for the development of an enterprise. They are one of the fundamental components that determine the competitiveness of an enterprise and its prospects in the market. Innovation is the form of new products or improved products. the latest technologies for their production, means of production. Innovations cover the latest methods and forms of organizing all types of activities of companies and other parts of public production. Innovation activity is a complex process of creating, using and implementing newly acquired ideas and knowledge in order to gain competitive advantages and increase profits. In particular, innovation activity is one of the most essential components that allow an enterprise to take a stable position in the market and gain advantages over competitors. The decisive role of innovation processes plays an important role in the modern economy, the definition and consideration of these features is an indispensable condition for ensuring the effectiveness of the economic strategy of the enterprise.

The effect in innovation should be understood as the end result of innovation and the cost of its implementation. It should be noted that in modern conditions there are practically no unified and scientific methodological approaches to assessing the effectiveness of innovative activities of industrial enterprises. It should be noted that in order to successfully implement innovative projects and determine the main directions for introducing innovations, it is necessary to conduct a detailed analysis that allows one to form criteria for management decisions in order to characterize and evaluate the success of introducing innovative activities. The main role in increasing the innovative activity of companies is played by the choice and implementation of a specific strategy for the company's innovative development. The analysis of innovative potential implies the study of aggregate resources, namely intellectual, material, financial, human, infrastructural and additional sources of improving the results of innovative activity. At the present stage, for enterprise management, the financial ability of enterprises to develop the innovation sphere is of the greatest importance. In general, under the assessment of the effectiveness of innovative activity, enterprises consider a management function aimed at studying the state, development trends, an objective assessment of the results of innovative activity and developing recommendations on this basis to further increase the level of its effectiveness.

Innovative activity is a complex process aimed at the development of innovations, the implementation of the results of completed scientific research or certain scientific and technical achievements in a new or improved product sold on the market, in a new or improved technological process used in practical activities, as well as related process of scientific development and research.

It can be argued that the purpose of assessing the effectiveness of innovation is a comprehensive analysis of the effectiveness of innovation and its impact on the most important indicators of the enterprise, determining the feasibility and optimal options for implementing innovations, promptly adjusting the parameters of innovation projects and supporting strategic innovation decisions, monitoring and forecasting potential challenges.

Innovation activity is an extensive system of measures aimed at realizing the intellectual and technical potential of an enterprise in order to meet the needs for innovation and receive

profit on this basis. In modern economic market conditions, innovations should contribute to the intensive development of the enterprise, ensure the acceleration of the introduction of the latest achievements of science and technology into production, and more fully meet the needs of consumers in a variety of high-quality products and services. We can assume that innovation has now become one of the most important factors in the effective functioning and development of economic systems. This activity is constantly in need of improvement processes in accordance with the objective requirements of the market. It becomes a reality when it is clearly outlined in the methodology for introducing innovations and evaluating their effectiveness.

The innovation model should become dominant. Innovative development is based on the general principles of the cyclical development of scientific and technological progress, which determines the continuity of the change of generations of equipment and technologies, and provides for possible alternative options for the introduction of scientific and technical innovations (Latyshev & Akhmetshin, 2015).

Certain innovative activities should be precise of a strategic nature, and in the long term, as well as strategic even in real-time. Innovative activity should also be of a tactical nature, that is, it should be rational both in terms of the sequence of actions and in terms of their certain timeliness, which ultimately will ensure the certain dynamism of innovative activity required by the situation. It is in the strategic plan that innovative activity is determined by such indicators as the quality of a certain innovative competition strategy, the level of mobilization of a certain innovative potential, the level of attracted capital investments, that is, investments, the level of various methods that are used when carrying out innovative changes, the validity of the implemented level of a certain innovative activity (Idris & Durmusoglu, 2021).

Planning is one of the main components of the enterprise innovation management system. It allows you to analyze the market situation and forecast possible directions of its change to identify promising areas for the development of the enterprise. The system of planning and forecasting innovative activity largely determines the strategy and tactics of the economic development of an enterprise in the main areas of its activity. The methodical approach we propose, which includes a set of easy-to-use modeling methods, can help to display the necessary information about the process of implementing certain management decisions, which contributes to effective planning (Saidi et al., 2021).

Most scientific developments are fragmentary, which cannot be the basis for a comprehensive solution to the problem of forming an appropriate information model for the management system of innovative activities of industrial enterprises in the context of economic development. Therefore, the main purpose of the study is to form a methodological approach to the management system of innovative activities at enterprises in the context of their economic development.

Given this, the value of our study lies in the fact that innovation is by its nature a phenomenon whose development is difficult to fit into a clear algorithm, while our study suggests using a clear and consistent method for this, based on the methodology of the functional. modeling. The use of this methodology is an auxiliary method in the process of innovative activity at enterprises in the context of economic development. In addition,

an important advantage of this method is that the implementation of a large task in the context of the process of innovation in enterprises can be divided into several sub-stages using decompositions of lower levels.

The structure of the paper includes the analysis and evaluation of scientific and practical literature; formation and description of the research methodology; presentation of the main results of the study; the formation of basic scientific opinions in a discussion sector; generalization of the results obtained through conclusions; list of used scientific sources.

1. Literature review

The economic development of any socio-economic system (including enterprises) depends on many factors, including innovation. Not infrequently in the scientific and practical literature (Remeikienė et al., 2020; Übius et al., 2013), one can find the fact and emphasis on innovation as a key element of economic development.

We believe, based on the analysis of scientific literature (Snieska & Valodkiene, 2015; Lorincová et al., 2022), that it is in the context of economic development that the innovative activity of enterprises should be considered.

In general, the vast majority of scientists (Iermakova et al., 2021; Lundvall, 1992) agree that innovation at the present stage of economic development is becoming the main means of maintaining the competitiveness of enterprises.

Exploring scientific and literary sources, one can see how relevant the problems of innovative development and innovative activity of enterprises are today. After analyzing the theoretical approaches of various authors (Prokop & Stejskal, 2017; Okoń-Horodyńska et al., 2020), we concluded that innovation activity should be considered as a process aimed at developing innovation. research or certain scientific and technical achievements into a new or improved product sold on the market, into a new or improved technological process used in practical activities, as well as scientific developments and research related to this process.

There are opinions that the innovation management mechanism is always aimed at achieving specific innovation goals by influencing the factors that ensure their achievement. This influence is carried out through the available resources of the organization, among which the leading place belongs to human resources. A person as a social being can be motivated to a certain activity if such activity is highly valued by society if the social status and material well-being of the individual depends on its effectiveness (Bierwiaczonek et al., 2020; Coenen et al., 2017; Hurzhyi et al., 2021; Camisón & Villar-López, 2014).

In general, by analyzing scientific works and literature, we understand how important and difficult the process of managing the innovative activity of an enterprise is. How many processes and subprocesses are in it, each of which works to achieve its goals.

The study of scientific and practical works only confirms the fact that innovation activity is very sensitive to the negative impact of certain factors. For example, negative factors affecting innovation activity caused by the annual reduction in the number of innovation-active enterprises, unstable institutional and legal support, the lack of a favorable investment climate, and access to information (legal, reference, scientific and technological,

commercial). both in the process of creation and functioning of enterprises, the inadequacy of the system of organization of production and the level of management to the tasks of innovative development, and insufficient support for domestic science (Li et al., 2019; Hajek & Henriques, 2017; Gündüz & Semercišz, 2012).

The innovative activity of enterprises is considered all over the world. For example, Adekola et al. (2008) explore the key aspects of the innovation activity of Lithuanian enterprises. And in general, the countries of the European Union often become objects in this scientific field (Gzzebyk & Stec, 2015; Szczepańska-Woszczyna & Dacko-Pikiewicz, 2014). We believe that in this case, Ukraine, as a part of Europe, also has the right to be considered in the field of innovation as a model of international experience.

At present, the innovative activity of an enterprise is defined as a basic factor in maintaining the competitiveness of an enterprise in the market. So, Xuyen et al. (2022) in the study determined the basic conditions for maintaining a high level of innovative activity at enterprises in the conditions of modern economic development. In their opinion, the main condition for the implementation of effective innovation activities, which concerned all elements of the production and management process, is the formation of a powerful innovation management system, which was based on the passage of specialized courses, training, and constant support from the management.

Knowing the proper number of developments in the field of innovative development, and innovation management, it should be noted that the information support of the management system in that area is still not fully disclosed. Our study attempts to offer a methodological approach that will allow us to demonstrate the main aspects of each stage when deciding on the field of innovation and economic development.

2. Methodology

Theoretical methods included the basic methodology of analysis, synthesis, and systematization of the information obtained from scientific and practical literature, which made it possible to better understand the essence of the management system for the innovative activity of an enterprise in the conditions of its economic development.

The practical group of methods included only the methodology of functional modeling and graphic representation of processes (IDEF0). This methodology in mathematics or modeling is not new and should not be considered the first to use it. It appeared to us and will be after us, but its main purpose was to structure and model the processes of any socio-economic system. This is where companies and their innovative activities come in.

The interview method was used only partially to communicate with the management of industrial enterprises in Ukraine (the choice fell on them due to the COVID-19 restrictions) to understand the practical side of the work of the innovation departments of enterprises.

Each method we use aims to support the functional modeling and process graphical representation (IDEF0) methodology. So, first, it is necessary to single out the key basic parts for the formation of our model for the implementation of managerial decisions on the innovative activity of an enterprise in the conditions of economic development (Table 1).

Table 1. Key basic parts for the formation of our model for the implementation of managerial decisions on the innovative activity of an enterprise in the context of economic development

Basic part	Characteristics for our study
The main goal of the modeling process	Develop a functional model that will facilitate information support in making managerial decisions on the innovative activities of enterprises in the context of their economic development.
The main audience of the current model	We believe that the key audience of the developed model should be employees and management of departments and teams for innovative development and enterprise activities. This also includes employees responsible for the economic development of the enterprise.
Model main content	The content of our model includes several functions and diagram objects of the IDEF0 functional model.
Software	To develop our model, we used an example program that allows generating vector diagrams.

In itself, the management system for the innovative activity of an enterprise in the conditions of its economic development is a certain set of stages and sub-processes that should turn certain resources and information into a certain desired socio-economic effect. So, to build our functional model, let's set our main goal – Ensure effective innovative activity of the enterprise (A_0). Thus, A_0 is the highest level of our model and in order to achieve it, it is necessary to perform a number of steps and processes (A_1, A_2, A_3). We decided that for a better presentation of how to achieve A_0, we should apply the "Decision tree" method, which best depicts our vision of this process (Figure 1).

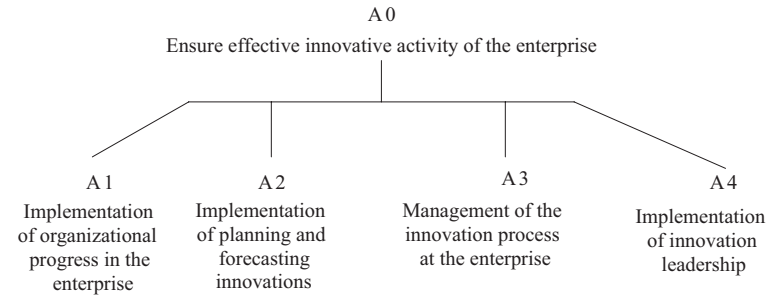

Figure 1. The main hierarchy of achieving A_0 for building a functional model

The "Decision tree" method allows us to depict in detail what the main goal is, and which are auxiliary to achieve it. In our case, the "Decision tree" method is an additional one for a better understanding of the modeling process.

Next, we need to show the main inputs and outputs in our model. Here, for a better understanding, the "Black Box" method should be applied and thus the main elements will be better understood (Figure 2).

So, the basic and initial elements were presented with the help of extraneous and auxiliary methods. All the methodology we use is aimed at better displaying the basic information before the modeling process. The main models will be presented later in the text.

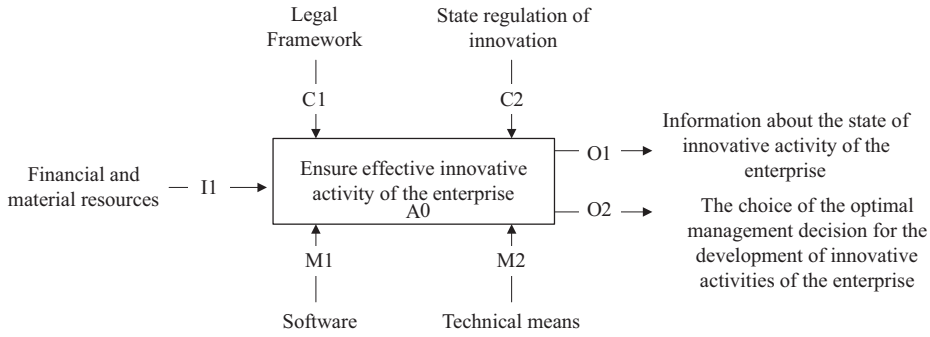

Figure 2. Application of the "Black Box" method for better display of input and initial information on the formation of a functional model

3. Research results

Let's build the main decomposition of the functional model and graphic representation of the process of managing the innovative activity of an enterprise in the conditions of economic development (Figure 3).

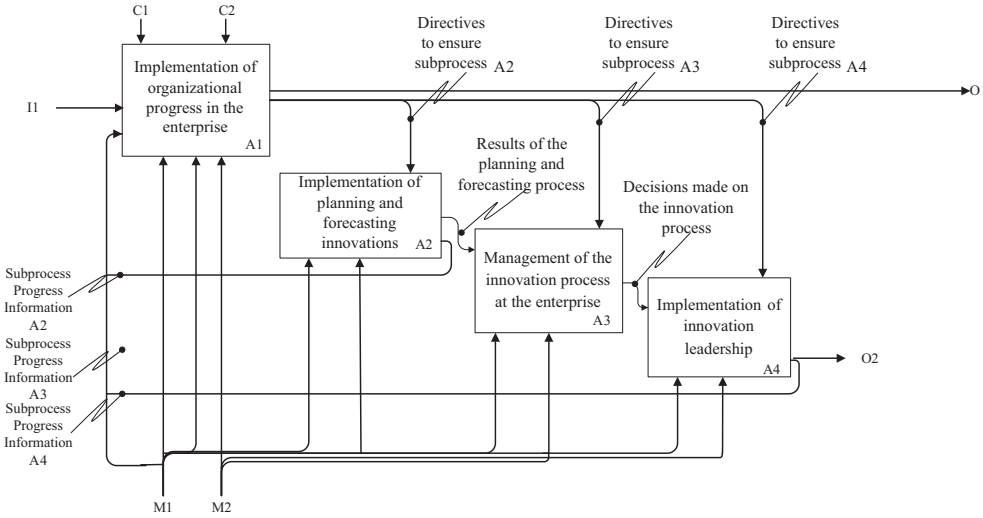

Figure 3. The main decomposition of the functional model and graphic representation of the process of managing the innovative activity of an enterprise in the conditions of economic development

I_1 – represents input information or a specific input element. In our case, these are just financial and material resources.

C_1, C_2 – is a certain element of control. In our case, this is just legislative regulation and a system of state regulation.

M_1, M_2 – are organizational and technical mechanisms to ensure the achievement of our goal.

O_1, O_2 – represents the source information or source element. In our case, this is exactly the information that we receive as a result of the execution of each subprocess.

"Subprocess Progress Information about A_2, A_3, A_4" is the information that will come from each of the subprocesses when implementing the innovation management system in the enterprise. Appropriate decisions of a positive nature (transition to a new subprocess) or negative (termination of the subprocess) should be made on its main ones.

"Directives to ensure subprocess A_2, A_3, A_4" must be the established results of management decisions that determine the direction of one or another subprocess.

So, let's clarify each element of our model in detail:

A_1 – Implementation of organizational progress in the enterprise. Organizational progress acts as a generalized feature of the process of using organizational development factors and increasing production efficiency. The decomposition of the functional model for achieving the process "A_1 – Implementation of organizational progress in the enterprise" is shown in Figure 4.

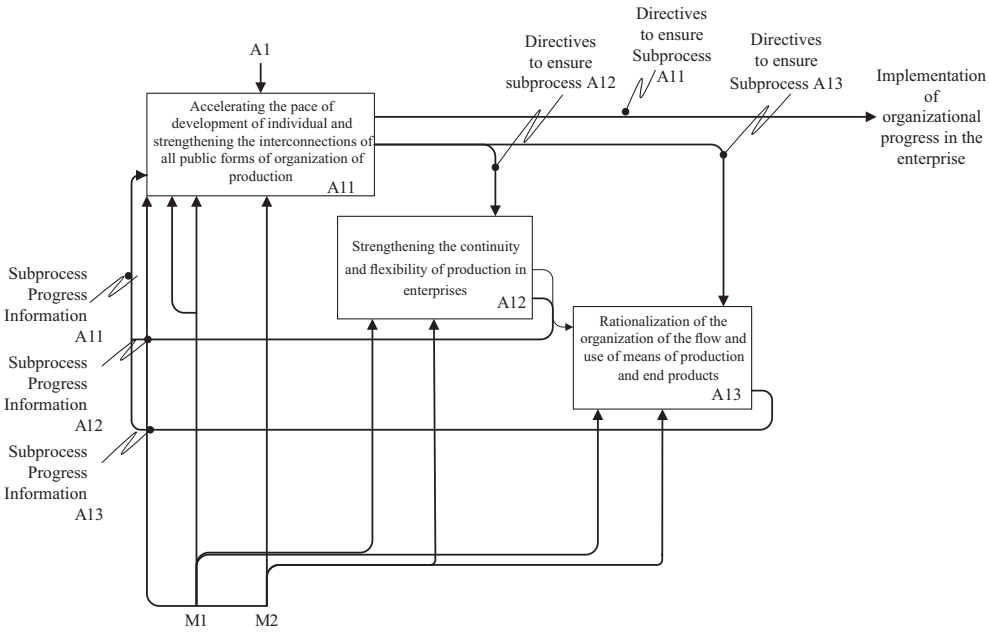

Figure 4. The decomposition of the functional model for achieving the process "A_1 – Implementation of organizational progress in the enterprise"

Therefore, to achieve "A_1 – Implementation of organizational progress in the enterprise" it is necessary:

A_{11} – Accelerating the pace of development of individuals and strengthening the interconnections of all public forms of organization of production. This will ensure the demonopolization of the production of many types of products, the competition of producers in the market, the multiplier efficiency of enterprises, and economic systems.

A_{12} – Strengthening the continuity and flexibility of production in enterprises. This can be achieved through the wider use of automatic rotary lines of robotic complexes and flexible production systems, which make it possible to minimize the loss of time and resources, increase labor productivity many times over, and dramatically accelerate the renewal of manufactured products.

A_{13} – Rationalization of the organization of the flow and use of means of production and end products at all stages of the reproduction process. It is necessary to transfer a certain part of the organizational and technological operations for the preparation of production to the sphere of logistics, which contributes to a significant reduction in the production stocks of raw materials, materials, and fuel, a decrease in the volume of their implementation, and the disposal of production waste.

A_2 – Implementation of planning and forecasting innovations. Planning and forecasting as a management function allow enterprises to correctly orient themselves in the market environment helps to make the right administrative decisions, and increase the likelihood of achieving the desired success. The decomposition of the functional model for achieving the process "A_2 – Implementation of planning and forecasting innovations" is shown in Figure 5.

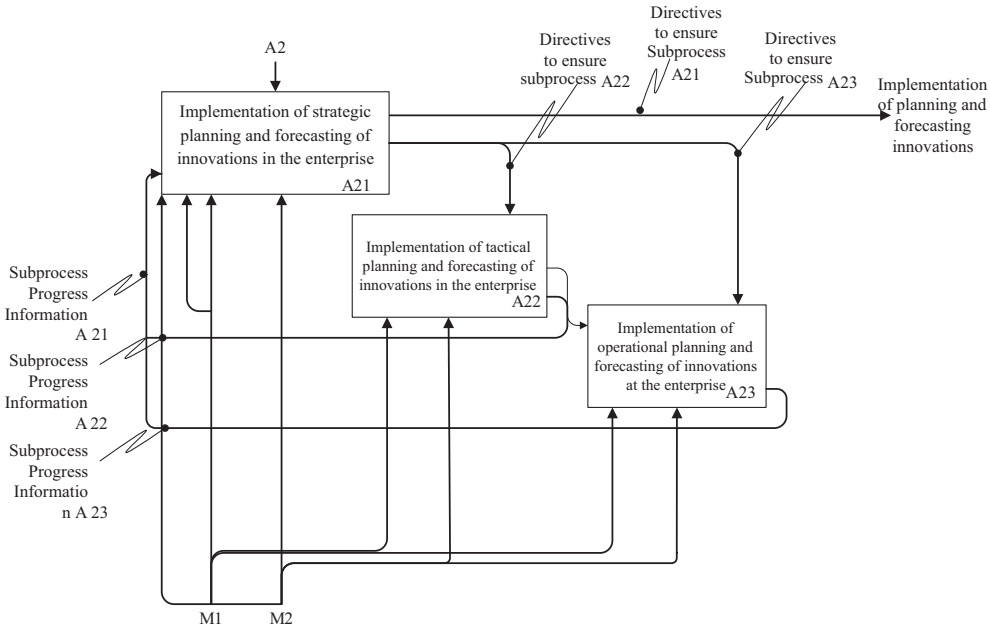

Figure 5. The decomposition of the functional model for achieving the process "A_2 – Implementation of planning and forecasting innovations"

Therefore, to achieve "A_2 – Implementation of planning and forecasting innovations" it is necessary:

A_{21} – Implementation of strategic planning and forecasting of innovations in the enterprise. Strategic planning and forecasting of innovative activity are of a targeted nature, that is, it involves the setting and achievement of certain goals.

A_{22} – Implementation of tactical planning and forecasting of innovations in the enterprise. Tactical planning and forecasting of the innovative activity of an enterprise should include the process of creating prerequisites for the implementation of new opportunities for the strategy of innovative development of an enterprise, substantiating the tasks and means necessary to achieve established or traditionally accepted goals.

A_{23} – Implementation of operational planning and forecasting of innovations at the enterprise. Operational planning and forecasting should be used to determine the ways

and methods of solving problems within the framework of the tactical behavior of the enterprise, as well as quickly responding to unpredictable changes in the internal and external environment of the enterprise, therefore, it is characterized by a significantly higher level of specification and detail.

A_3 – Management of the innovation process at the enterprise. Management of innovative processes should cover strategic and operational aspects and should be, on the one hand, aimed at creating or promptly attracting innovations that ensure the preservation and strengthening of the company's market position in the long term, and on the other hand, systematic and purposeful activities to improve existing technologies, techniques and ways of doing work that prolong the life of innovations. The decomposition of the functional model for achieving the process "A_3 – Management of the innovation process at the enterprise" is shown in Figure 6.

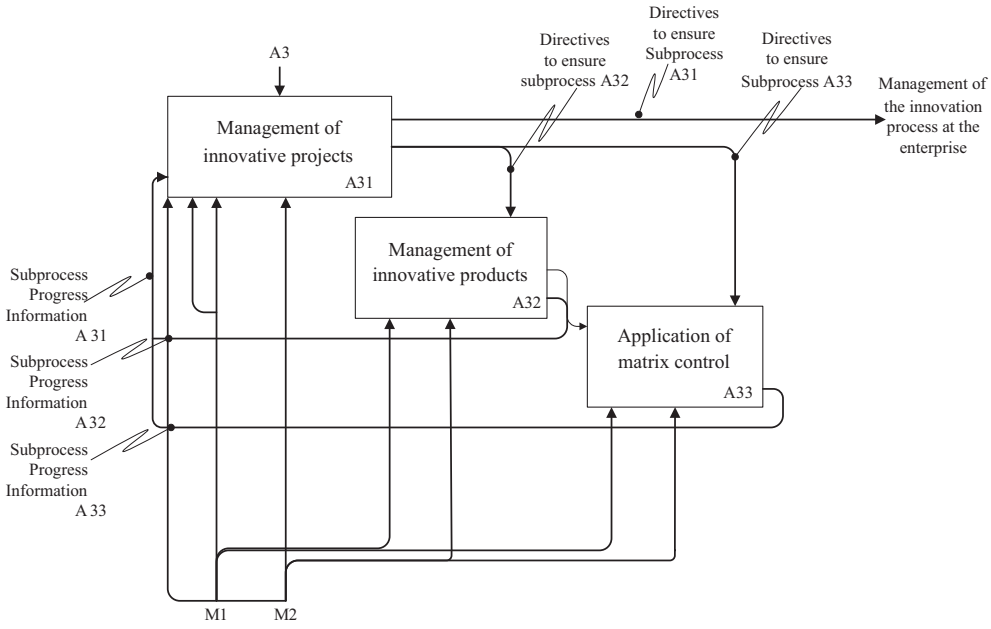

Figure 6. The decomposition of the functional model for achieving the process "A_3 – Management of the innovation process at the enterprise"

Therefore, to achieve "A_3 – Management of the innovation process at the enterprise" it is necessary:

A_{31} – Management of innovative projects. Provides for the creation of special structures for managing individual projects. Within the framework of this structure, the work and its performers are considered not from the position of the established hierarchy of subordination, but from the position of achieving the goal of the project.

A_{32} – Management of innovative products. It is formed during the implementation of several projects involving the introduction of goods that differ in manufacturing technologies and industries. Allocate management structures, each of which is assigned a separate group of goods.

A_{33} – Application of matrix control. Allows us to quickly form teams (groups) of specialists focused on the implementation of a set of works related to the development and promotion of specific innovations to the market. The groups include specialists from different departments who are subordinate both to the head of a specific innovation project and to the heads of the relevant departments and can, if necessary, turn to them, for example, for advice.

A_4 – Implementation of innovation leadership. Innovative leadership is an activity that a leader of an innovative type, innovative style of leadership and the use of new forms of power, based on influence through participation in cooperation and a combination of both the authority of power and power, authority in order to achieve a social, economic, scientific and technical effect. Innovation management should provide for the introduction of new products and technologies (innovation activity), the modernization and improvement of products and technologies, the further development of the production of traditional types of products, and the removal of obsolete products from production. The decomposition of the functional model for achieving the process "A_4 – Implementation of innovation leadership" is shown in Figure 7.

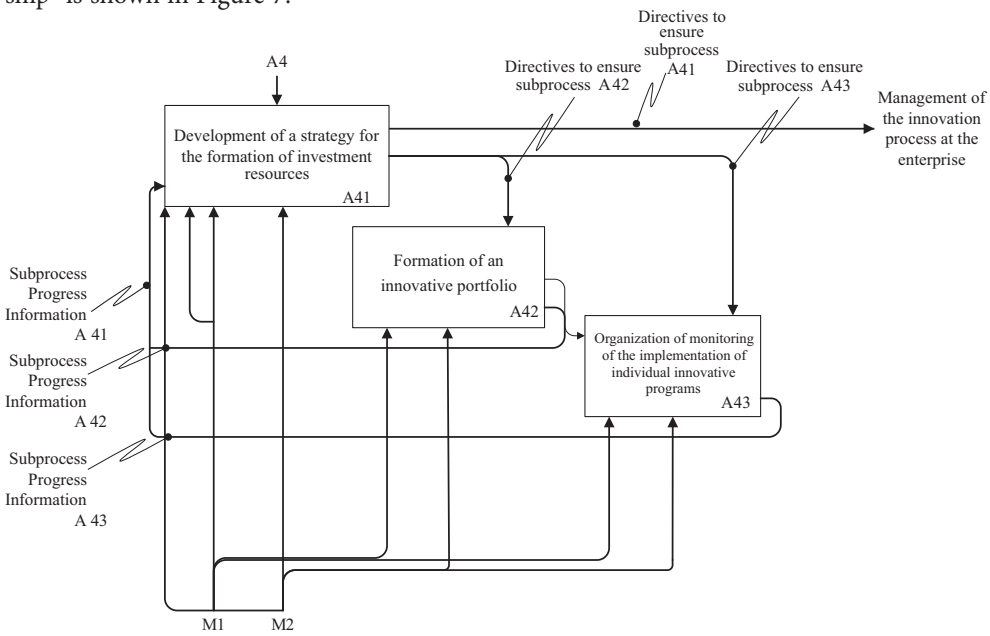

Figure 7. The decomposition of the functional model for achieving the process "A_4 – Implementation of innovation leadership"

Therefore, to achieve "A_4 – Implementation of innovation leadership" it is necessary:

A_{41} – Development of a strategy for the formation of investment resources of the company. It is necessary, when optimizing the structure of sources of investment resources, to ensure a rational ratio of own and borrowed funds, as well as the diversification of borrowed sources of investment financing for individual creditors and subsequent payment, flows to prevent a decrease in financial stability and solvency in the future period.

A_{42} – Formation of an innovative portfolio and its assessment according to the criteria of profitability, risk, and liquidity. By implementing this function, taking into account the

volume of investment resources that can be attracted, the calculated indicators of profitability, and the level of risks for each innovative project and financial instrument, they are selected for direct implementation.

A_{43} – Organization of monitoring the implementation of individual innovative programs and projects. When implementing this function, innovation management should form a system of primary indicators related to the implementation of each innovation program and individual innovation projects; determine the frequency of collection and analysis of information; identify the causes of deviations of implemented innovative projects from the scheduled time, volume, efficiency.

It should be noted that our model is more theoretical than practical since it has a low level of practical application. At this stage of the study, we were more interested in demonstrating how the methodology of functional modeling and graphic representation of processes works and how informationally it can be useful for the management system of innovative activity of an enterprise in the conditions of its economic development.

4. Discussions

Discussing the results of our study, this section should be divided into two parts. First of all, we should discuss how our study differs from others. Of course, we cannot cover all scientific research on this topic, but we will try to take a few comparative examples. So, for example, the very fact of applying the methodology of functional modeling and graphic representation of processes associated with the control system. The methodology itself is not new and has been used in many scientific fields. For example, several scientists (Sylkin et al., 2020; Godlevskyi et al., 2018; Kryshtanovych et al., 2020, 2021) directions as ensuring the financial, social and economic security of the enterprise or even at the state level (Glado et al., 2021; Sylkin et al., 2019) Nevertheless, our study focuses on the type of governance where this methodology is both relevant and new.

Discussing specific differences in the field of innovative activity of an enterprise and its economic development, we want to note that most scientists (Podra et al., 2020; Maceika & Šostak, 2014; Brockova et al., 2021; Borrás & Edquist, 2013) paid attention to the formation of an innovative environment and innovative development, whether it is an enterprise or another socio-economic system. Nevertheless, our study tries to demonstrate the main features of the enterprise innovation management system, while applying another new methodological approach that works well with management decisions.

As a result, in order to determine their opinion, we asked them several questions (this should not be considered a full-fledged expert survey, this is only for understanding the opinion of the management), which concerned the level of effectiveness of our model (only on a subjective level, of course). The results of such a survey are presented in Table 2.

So, according to many heads of Ukrainian industrial enterprises, we can talk about its convenience, flexibility, and effective display of the necessary information. Of course, positive feedback from a few industrial managers is not yet a significant indicator of performance, but in our opinion, this is a good start and a positive direction for further expanded research.

Table 2. Results of a survey of leaders of teams and departments for innovation and development at industrial enterprises of Ukraine regarding the effectiveness of our model

Company Name	Is the model easy to use?	Was the information provided clear?	Will you use it in the future?
PJSC "Conveyor"	Yes	Yes	Yes
PJSC "Odessa Machine-Building Plant"	Yes	Yes	Yes
PJSC "Electron"	Yes	Yes	Yes
PJSC "Kharkiv Electrotechnical Plant "Ukrelectromash"	Yes	No	No
PJSC "Poltava Machine-Building Plant"	No	Yes	No

Thus, our model is purely theoretical but close to the practical realities of the activities of Ukrainian enterprises (unfortunately, when in the conditions of military operations on the territory of Ukraine, we cannot analyze the practical activities of foreign companies).

Conclusions

The results of the study are the formation of key decompositions of the IDEF0 functional model for the management system of innovative activities of enterprises in the conditions of their economic development. The main decomposition involves several stages and in order to better reflect the effectiveness of the proposed methodological approach, each subprocess has been detailed separately. To better display the original data, a number of convenient methods have been applied to better reflect our ideas graphically. We tried to find a practical application of our model, and several industrial enterprises in Eastern Europe were chosen for this.

Of course, the study has limitations. And first of all, they concern the field of activity and geographical aspects. Thus, the verification of this model was conducted on the territory of Ukraine, under the conditions and specifics of the existence of the Ukrainian economy. Due to the negative impact of COVID-19, we have a situation where it is extremely difficult to get the effect of the practical application of our own scientific developments. Due to a number of restrictions, we were forced to apply our methodology only to industrial enterprises in Ukraine.

As for our recommendations, we believe that even with a successfully built model of the management system, and always formed department and team is important. The effectiveness of innovation management could be significantly improved by creating special departments or structural units on a permanent or temporary basis, such as an internal venture. Adapting the organizational structure of a large enterprise to the specifics of innovation activity will help to increase its efficiency, effectiveness, and economic development. And only then can the proposed methodological approach be effectively implemented. This will be especially relevant for industrial enterprises in Ukraine.

The study has several limitations, which are primarily related to the fact that, due to the conditions of the pandemic, its practical application took place exclusively at Ukrainian enterprises. Future research should be devoted to analyzing innovation under the influence of Industry 4.0, which is already so close that it is already difficult to talk about its beginning, since it has already arrived.

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