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STRUCTURE TRANSFORMATION OF INFORMATION ORGANIZATION SUPPORT OF INNOVATIVE PROCESSES AT HIGH-TECH ENTERPRISES ON THE BASIS OF ADAPTATION OF MULTILEVEL METHODS OF SIMULATION MODELING IN THE ENVIRONMENT OF THE DIGITAL ECONOMY

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ABSTRACT

The process of innovative development of knowledge-intensive industries should be implemented within a triangle: government, business and education/science, using various end-to-end innovation and digital solutions and project approach necessary to effectively organize the management process. The aim of the research conducted in the article is the qualitative development of methodological tools for the mechanisms of information support of various process groups in the field of innovation, through the use of actual methods of simulation modeling, which include components of machine learning, which as a result will improve the effectiveness of innovative project groups in high-tech enterprises. The scientific hypothesis of the study is the assumption that the effectiveness of various groups of processes associated with information support of high-tech enterprises in the field of innovation, can act as a qualitative basis for a consistent increase in the level of their competitiveness and reliability in the long-term strategic perspective. Scientific novelty consists in theoretical substantiation and development of methodological tools for competent and effective information support of practical activity of the enterprise, within the framework of its innovation policy, with the purpose of subsequent increase in groups of indicators characterizing economic efficiency of innovation and digital projects on the basis of application of simulation modeling methods, including components of machine learning. Theoretical and methodological basis of the study is based on scientific works devoted to the consideration of problems in the field of organization of information support in the field of innovation, scientific developments of profile experts/specialists in the field of artificial intelligence, economic and mathematical modeling. The authors made a multicomponent conceptual model of the organization system of information support for the life cycle of products of innovative type. A dynamic information model has been developed, which will allow the management of high-tech enterprise making optimal management decisions considering the turbulent economic environment. The authors propose an updated mechanism of organizational and economic management of innovative process groups at high-tech enterprises.

Keywords: *Information infrastructure, Kahonen map, Machine learning, Innovation and digital activity, Information assurance, Optimization of management processes, Databases.*

1. INTRODUCTION

The process of innovative development of knowledge-intensive industries should be implemented within a triangle: state, business and education/science, with the use of various end-to-end innovation and digital solutions. There is an urgent need for a qualitative transformation of the structure associated with production relations, actualization of the work of production and technological processes, revision of the mechanisms of management organization considering the new digital concept, and it is also necessary to qualitatively increase the level of requirements that are set for the communication and information systems. Under such conditions, the dominant factor that will qualitatively increase the level of sustainability and security in various industries will be high-tech enterprises, which can provide research and scientific development in the

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process of continuous digitalization of economic entities [1]. High-tech enterprises, the practical activities of which involve the implementation of various types of innovation, as well as the accumulation of intellectual capital, due to the high level of competition must necessarily conduct innovation activities on an ongoing basis in order to consistently improve their level of competitiveness. However, the process of innovative activity carried out by high-tech enterprises is closely connected with complexity of management organization, as there is a high level of heterogeneity/uniqueness of solved tasks, and, therefore, management almost every time should be reconstructed under new purposes connected with realization of certain decisions in the field of innovations. Effective operational management of various groups of innovations is impossible without full information support and subsequent information support at all stages of management [2, 3].

The main results representing the scientific novelty of the research conducted in the article are the following:

- conceptual model of information support for the innovation activity of knowledge-intensive organizations has been developed, the distinctive feature of which is the use of artificial intelligence (AI) and machine learning methods in solving problems of innovation activity;
- mechanism for the implementation of information activities in the context of the life cycle inherent in innovative products has been developed. It differs from the previously used ones by the possibility of describing the processes of the emergence of operational information as a result of the introduction and use of innovative solutions. The mechanism allows assessing the impact of innovation processes on the functioning of high-tech enterprises and taking into account changes in parameters and emerging risks in real time to achieve an economic effect in a shorter period of time;
- methodology for assessing the innovative activity of knowledge-intensive enterprises based on the analysis of available data is proposed, which differs from the existing ones by using the methods of machine clustering and intellectual analysis of information, which made it possible to direct the methodological tools used to optimize the economic indicators of knowledge-intensive enterprises to ensure their sustainable functioning in the long term;
- organizational and economic mechanism for organizing the process of managing innovation activity is proposed to optimize the structure of information support for innovation processes at science-intensive enterprises, which is distinguished by the use of tools for quantitative and qualitative assessment of management decisions, factors of competitiveness of an organization, information support, economic sustainability and economic efficiency of innovative projects, which provides the possibility of effective solving problems of optimal management of an innovative project in order to increase the competitiveness of high-tech enterprises.

The purpose of the research conducted in the article is the qualitative development of methodological tools in terms of the mechanisms of information support of various process groups in the field of innovation, through the use of relevant methods of simulation, which include components of machine learning, which as a result will improve the effectiveness of innovative project groups at high-tech enterprises. To achieve the goal, it is necessary to solve the following tasks:

- to design a simulation model, which will allow the management of a high-tech enterprise making effective and optimal decisions in the field of management, concerning the mechanisms related to the implementation of innovation activity;
- to develop a methodology that will allow obtaining operative estimates of the current level of innovation activity of high-tech enterprise on the basis of the analysis of various groups of information data;

- to develop and verify the methodology for organizing systems of on-line monitoring of the efficiency degree of projects practical realization in the innovation sphere on the basis of synthesized analysis of production and economic information;

- to offer a model that combines in its structure organizational and economic aspects of management of different groups of innovation processes in high-tech enterprise.

2. LITERATURE REVIEW

Consideration of information as an economic resource is reflected in the scientific works of foreign and Russian researchers: Hurwicz & Reiter [4], Magomaeva [5], Kolbachev [6], Coase [2], Cherkasova [7], Sergeeva [3], Uskova [8], Nelson & Winter [9], North [10], Tanenkova [11], Pyzhev and Goryachev [12], Orekhova [13].

Russian scientists such as Andronova, Shevchenko, and Osinovskaya [14], Chulanova [15], Moroz [16], Golichenko [17], Garina and Lysenkova [18], Britsko [19] devoted scientific articles to theoretical issues related to information support mechanisms within management structures.

Tangible contribution to the research of the methodological basis of the system responsible for the management of innovation activities in high-tech enterprises has been made by Russian scientists such as: Patrushev and Popov [1], Meshcheryakov and Asaul [20] Knyazev and Gancherenok [21], Sineva and Yashkova [22], Ilyakova and Loginova [23], Polukeeva [24], Shiryaeva, Pertseva, Lapshina and Lapshin [25], Yashin and Soldatova [26], etc.

Development of mechanisms of the tools range for information support of processes related to innovation activities in the context of management organization on the basis of simulation modeling methods assumes that there will be a detailed elaboration of the composition of criteria, on the basis of which the level of effectiveness will be subsequently determined. Practical use of methods of machine learning, AI technologies in solving economic problems gives tangible advantages to the enterprise [27]. Many subject matter experts characterize the modern model of the economy as turbulent, subject to strong changes caused not only by scientific and technological progress, but also by digital technologies, which every day are more and more actively integrated into various spheres of society [28]. High-tech enterprises, undoubtedly, need to carry out innovation activities on a constant basis, to have at their disposal up-to-date ways of information support of the operation process of various innovation components, which ultimately form the level of competitiveness [10, 26]. The information now represents the basic economic resource which is capable to render significant influence on process of innovative development, a level of efficiency of work of industrial sector of the enterprise that in uneasy modern conditions defines a vector of information support in a cut of conducting by the enterprise of innovative activity [29].

The study of patterns in the development of information technology, the experience of their practical use in the difficult conditions of development of the digital economy and knowledge-intensive sector has led to a search for fundamentally new solutions, which will be based on multidimensional structured information [4]. In the process of integration and subsequent application of solutions in the field of innovation, high-tech enterprise needs to use the full cycle of information support for all processes in the field of innovation [30]. The authors' analysis of the current problems made it possible to identify the causes of technological, technical, as well as organizational and informational lag of the vast majority of Russian high-tech enterprises from similar foreign productions, which justifies the need to already use a comprehensive system approach, which includes all the main stages of the innovation process in its structure [31, 32]. In the framework of the research, the authors propose the interpretation of the concept of "information support of innovation activity processes at science-intensive and high-tech enterprises". The authors define this concept as a process connected with providing innovations with necessary information by means of various means of data processing and analysis in order to carry out optimization of innovative activity connected with creation, production and subsequent commercialization of results of their work on the basis of information support and making competent decisions in managerial sphere [33]. Optimal management of innovation activities within the framework of the tasks of quality and prompt processing of a sufficiently large amount of information is possible through the use of machine learning and AI technologies, that is, modern

methods that allow the processing of sufficiently massive amounts of data, which ultimately allows [8, 23]:

- considering in a multi-component production structure complex relation of technological type;
- qualitatively improving accuracy, efficiency in the development and adoption of various types of decisions in the field of management [34];
- evaluating the level of sustainability and adequacy, adopted by the management of the enterprise solutions in the field of economics, which were obtained on the basis of their application;
- forming a unique methodological toolkit in the field of information support of innovation activity of high-tech enterprises on the basis of simulation modeling methods [35].

In IT industry, simulation is beginning to be used in business information systems: from planning systems in ERP, SCM, APS systems, analysis and optimization tools in business process modeling systems (BPMS), integrated planning and supply chain management, etc., to interactive models of situation centers, scenario planning methods in decision support systems (DSS, EIS) and strategy formation in business performance management systems (BPM); including high technologies of modern digital production in systems of continuous product life cycle support (PLM) [36-38].

Within the limits of conceptual model necessary for realization of information support of practical activity in the field, spent at the high-tech enterprises of innovative policy, in article authors offer the information algorithm allowing to carry out support of the decisions accepted at the enterprise (Figure 1). A fundamental difference is the use in this algorithm of a complex of digital solutions/technologies, machine learning methods, to obtain quantitative and qualitative assessment required to organize competent and effective management of the life cycle of innovative products produced by the enterprise [14]. The algorithm proposed by the authors is based on the synthesis of existing solutions and contains in its structure the key components necessary for organizing information support for the practical activities of enterprises in the field of innovation, which ultimately helps to improve the quality of management in the context of the work of innovation process groups [9]. Operational digitalization of processes in the field of innovation through the use of various methods of intelligent data/information analysis allows identifying the possible range of problems in the work of production processes, which allows making decisions with scientific justification [31].

3. METHODOLOGY

Theoretical and methodological basis of the study is based on scientific works devoted to the consideration of problems in the field of organization of information support in the field of innovation, scientific developments of profile experts/specialists in the field of AI, economic and mathematical modeling. The scientific hypothesis of the current study is the assumption that the effectiveness of various groups of processes associated with information support of high-tech enterprises in the field of innovation, can act as a qualitative basis for a consistent increase in their competitiveness and reliability in the long term strategic perspective [17, 24].

The algorithm proposed by the authors is based on the use of modern methods in the field of machine learning and AI, which allows making decisions in the field of management, which will achieve the desired economic effect [28]. The application of this algorithm allows to a certain extent unifying the process of developing management decisions, reducing them to general methodological recommendations for high-tech and knowledge-intensive enterprises, which will include the following constituent stages [18]:

Stage 1. Identification and analysis of possible information, which consists of two components (internal and external information).

Stage 2. Development of special databases, in this case we are talking about Big Data technology in order to organize the storage of the information obtained in the first stage.

Stage 3. Professionals determine the methods of Data Mining, as well as machine learning, which can be applied to the analysis of different data (structured/unstructured).

Stage 4. Database design, based on the practical implementation of Data Mining methods.

Stage 5. Development of expert system implementing the support of decisions based on a single knowledge base, followed by the formation of various options for solutions in the field of management organization.

Stage 6. Creation of necessary conditions for project management in the sphere of innovations at the enterprise that allow improving the realization of control groups of influences on it.

The basis for the organization of information support of various groups of innovative processes within the framework of the research conducted by the authors, is the design of the system necessary for the organization of quality support of the life cycle of innovative products developed by the enterprise. This system will describe the various processes of emergence, formation, transfer and subsequent provision of operational information, due to the integration and application of innovation, as well as its impact on innovation processes [19]. Within the framework of the proposed stages of the life cycle of innovative products, in the structure of the information support system, there should be certain separation levels, within which the use of information occurs (Figure 2).

4. RESULTS

Within the framework of the research conducted by the authors, a model was compiled to describe the work of real economic groups of processes that take place within a high-tech enterprise, taking into account the fact that they are subject to a certain influence of random/unspecified groups of factors [22]. The application of the proposed model allows investigating innovative processes and describing them with a high degree of accuracy at the level of understanding of the formed tasks, in order to obtain an optimal and effective solution in the field of management. The compiled simulation model belongs to the class of dynamic models [32]. For the constructed given simulation model it is necessary to enter the main indicators:

- $L(t)$ is the data/information flow;
- $L_0(t)$ is the information obtained from external groups of sources;
- $L_k(t)$ is the operational data from a high-tech enterprise;
- $L_b(t)$ is the information from various databases (1,2,3….m);
- $L_c(t)$ is the information from various databases;
- $L_q(t)$ is the management decision-making.

Finding the formula needed to solve this problem will not be possible without making certain dependencies:

$L_p = Y_0(L_0)$, where L_p has a dependence on L_0, Y_0 is the information.

The next step involves determining relations and certain dependencies for the remaining indicators:

$$L_v = Y_v(L_k), L_r = Y_r(L_b), L_q = Y_q(L_c).$$

Then from the above chain of dependencies we can build a system of equations, therefore:

$L_k = Y_0(L_0, L_q)$, where L_k has a dependence on L_0 and L_q. Then, using substitution methods, we obtain an equation that contains one unknown:

$$L_k = Y_0(L_0, Y_v, (L_r(L_q(L_b(L_c))))).$$

From the above equation we find L_k, and then the remaining unknowns: L_b, L_c, L_q. Consequently, the solution of the basic equation will be a competent and effective solution in the field of management, which is taken on the basis of information of operational type. The Figure 3 shows a scheme of implementation of the optimal solution in the field of control. Due to the application of a set of digital tools, the speed of problem solving increases significantly, and thus the level of economic efficiency, which is determined by the optimization of design time and creation of products of innovative type, as well as the election of the most optimal types of risks for high-tech enterprise.

The methodology proposed by the authors for analyzing the level of innovation activity of a high-tech enterprise is not limited only to assessing the scale in the area of design, integration and diffusion of innovation, but involves the selection of

directions in the area of innovation development with subsequent formation of innovation policy, due to expert analysis of various groups of economic data. It is necessary not only to use well-proven methods of factor, deterministic or horizontal/vertical analysis, but also new effective methods of analysis and evaluation of economic data, for example, such as neural networks [11, 13].

It is reasonable to analyze different groups of economic information using Kohonen neural network, which implies the division of the set of categories of economic objects into separate groups and subgroups of clusters with the subsequent selection of some criteria. The criteria are considered conditionally optimal, which allows determining the type of objects and considering them homogeneous or heterogeneous [36, 39]. The process of constructing networks as well as self-organizing Kohonen maps when analyzing information, allows starting solving key problems related to clustering data, reducing the dimensionality of data, identifying unique hidden relations that may be present in multiple sets of multidimensional data [15, 21]. Kohonen maps are characterized by the speed of analysis, depth, accuracy and clarity, which is almost absent in the classical economic methods. When applying neural networks, Kohonen maps to increase the level of innovation activity in the context of high-tech and knowledge-intensive enterprises, it is possible to solve the following groups of problems [12]:

- identification of the most dangerous trends in the practical implementation of various projects in the field of innovation, which need operational management;
- ability to quickly track the complex non-linear relation of a sufficiently large number of parameters included in the innovation project;
- increasing the timing and accuracy in making management decisions [40];
- increasing the level of economic efficiency in the context of innovation.

The use of the method of clustering information of economic type by applying the method of neural networks and Kohonen maps has a vector of orientation, which is associated with the optimization of resource and financial costs, which ultimately contributes to the growth of scientific and technological level, commercialization of R&D results, due to which the level of activity of high-tech enterprises in the field of innovation increases. The process of assessing the results of innovation activity of high-tech enterprises can be represented as the following scheme (Figure 4).

The proposed methodology allows at the early stages of development of an innovative project determing the possible additional costs, actively assists in the horizontal integration of R&D, which has a tangible impact on the final results of innovative activity of a high-tech enterprise. A qualitative increase in the level of innovation activity of high-tech enterprises will be impossible without creating special economic tools and developing a methodological apparatus for assessing quantitative economic information, through the use of machine learning and AI methods for analyzing data arrays [6]. The proposed methodology of operative monitoring of the level of efficiency and quality of implementation of various projects in the field of innovation, based on a comprehensive analysis of economic information, and schematically shown in the Figure 5.

Operational provision of information of innovative projects, is that it is necessary to use practical data on the implementation of projects, which come in real time. Such data contains only a certain set of actual data, which will then require classification and data processing by means of AI, which will reveal hidden information that it may contain about the operation of processes at a high-tech enterprise. The methodology is based on the use of self-organizing Kohonen maps which allow automatically, without involving experts/specialists, searching for basic clusters in the basic information, to identify priority data which are necessary for the development of solutions in the field of management [36]. However, in this approach, there is also a problematic aspect associated with tracking the point in time when it will be necessary to implement changes in project management [5].

The work of a high-tech enterprise is also considered as a part of the implementation of regional policy measures in the long term, in this regard, it is proposed to develop special tools that allow assessing the level of impact of innovative activity on the processes of development of the region's economy in the contour of the medium and

long term. Such a tool is a regional simulation model, which allows assessing the level of effectiveness of the innovation policy pursued by the enterprise, determining the quality of managerial decisions made, which will ultimately allow a high-tech enterprise to choose the most effective option based on the scenario approach (Figure 6).

5. DISCUSSION

The range of tasks solved by simulation modeling can be divided into separate three abstract levels:

- low level of abstraction (large number of details, micro-level, operational type of management);
- medium level of abstraction (mesolevel, development of decisions in the field of tactics);
- high level of abstraction (minimal amount of details, macro-level, development of decisions in the field of formation of strategies).

The process of carrying out optimization of information support for various groups of innovation processes at high-tech enterprises is aimed at developing a strategy, which should elaborate the mechanism of information support of enterprises in the field of innovation [7].

It is necessary to determine what is the purpose of such optimization? The key goal of such optimization is to provide competent and effective information and analytical support, which is necessary when solving a set of problems in the field of management of high-tech enterprises, and it will allow them to obtain the necessary information for the development of management decisions [41].

As a rule, innovation activity is inherently uncertain, it is to some extent affected by various groups of digital processes, and therefore the application of classical approaches for its optimization/planning is difficult. It is necessary to actively stimulate innovation activities by creating an effective and efficient organizational and economic mechanism, which should improve the quality of its work through the use of innovative tools in the field of information support [3].

The question arises, what areas can be developed as a result of this mechanism? The mechanism is designed to improve the organizational and economic activities, which will develop a range of directions, which includes:

- increase of groups of economic indicators, i.e. computing facilities are used in a rational way, resources are saved, marketing costs are reduced, etc.;
- emergence of profile specialists in the field of information support, as well as the formation of new competence groups at the enterprise [34];
- innovation system is formed on the basis of advanced solutions in the field of working with information [16].

It is necessary to determine what is the difference between the author's view on the work of organizational-economic mechanism from the already known views/interpretations? So at the core of the author's organizational-economic mechanism are tools for assessing decisions in the field of management, factors that determine the level of competitiveness of the enterprise, provide information support and increase the degree of sustainability in the economic security of the project (Figure 7).

AI refers to a certain ability of software to perform manipulations similar to actions implemented under the control of the human brain. AI is a complex multi-level system that aims to replace human mental activity in managing a variety of enterprises, projects, operations, etc., created using machine learning methods and approaches that include a variety of algorithms [38, 39]. Machine learning is a system of successive stages of building algorithms that form the basis of AI. Therefore, machine learning is a part of AI research area (Figure 8).

The scheme of individual elements of the organizational and economic mechanism of innovation management, proposed by the author, is shown in the Figure 9.

Improving the organizational forms of introducing innovations involves changing the methodological principles on which the management of new projects is based. The development and use of these principles make it

possible to substantiate and specify the content of the organizational and economic mechanism for managing the innovation process. The organizational and economic mechanism implies a clear distinction between the principles, functions, methods, factors and tools of innovation management. The stages of the innovation process include its individual phases, from the stage of research to the stage of production and marketing of new products [42].

6. CONCLUSIONS

An organizational and economic mechanism for managing innovation activities is proposed to optimize the information support of innovation processes at high-tech enterprises, which is distinguished by the use of tools for quantitative and qualitative assessment of management decisions, factors of the organization's competitiveness, information support, economic sustainability and economic efficiency of innovative projects, which provides the ability to effectively solve the problems of optimal management of an innovative project in order to increase the competitiveness of science-intensive enterprises. A technique for operational monitoring of the effectiveness of the implementation of innovative projects based on the analysis of economic information has been developed, which differs from the existing ones by the ability to quickly monitor the multidimensional nonlinear relation of a large number of parameters characterizing an innovative project and consists in selecting parameters and analyzing their deviations from planned values to find problem areas in an innovative project in order to increase its economic efficiency. The implementation of this technique allows building a closed cycle of information support for the innovation activity of science-intensive enterprises, in which information analysis of heterogeneous economic data plays a fundamental role.

A methodology for assessing the innovative activity of knowledge-intensive enterprises based on the analysis of available data is proposed, which differs from the existing ones by the use of machine clustering and data mining methods, which made it possible to direct the methodological tools used to optimize the economic performance of knowledge-intensive enterprises to ensure their sustainable functioning in the long term. A simulation model has been developed for improving the processes of making optimal management decisions in relation to the innovative activities of high-tech enterprises, which differs from those previously used in the possibility of describing the processes of emergence of operational information as a result of the introduction and use of innovative solutions. The model allows assessing the impact of innovation processes on the functioning of knowledge-intensive enterprises and taking into account changes in parameters and emerging risks in real time to achieve an economic effect in a shorter period of time. The formation of this model made it possible to develop an information decision support scheme, including a step-by-step procedure for sequential actions for the formation of managerial decisions when managing the life cycle of innovative products of science-intensive enterprises, as well as to create an information support system for the life cycle of innovative products that allows displaying all the factors and relationships of the real situation in the analysis alternative courses of action to achieve the intended goal.

Practical use of the technique offered by the authors gives the chance to raise qualitatively a level of the decisions accepted in sphere of economy that leads, to increase of a level of efficiency in a part of application of innovative decisions which finally favorably influence level of competitiveness of the enterprise. The authors propose a step-by-step algorithm, which is aimed at analyzing various economic information for the purpose of increasing the quality level/efficiency of decisions in the sphere of management made by company management on the basis of making Kohonen nets. The proposed algorithm includes the following stages:

Stage 1. Conducting an analysis of the operation of production processes at the enterprise, identifying the key information flows that may appear in the implementation of activities in the field of innovation (design, development, project work) by a high-tech/science-intensive enterprise. The practical result of this stage is to obtain the key information flows (economic type), which will be necessary for further development of the methodology.

Stage 2. Creation of the special tables of classification on the basis of the data, which were received from Kohonen nets. For this purpose it is necessary to initiate a special procedure, connected with the realization of Kohonen net algorithm, using normalization of the initial vector, followed

by the finding of the closest vector. If the structuring of information (economic) has low level, it is necessary to initiate the procedure of hierarchical analysis of information/data.

Step 3. Perform intellectual analysis of information (economic). As a result of the analysis, information of a certain type is singled out, which is used to develop operational/strategic management decisions.

Stage 4. Development of management decisions based on the principle of information feedback. Taking into account the resulting information picture, as well as the conclusions received, concerning the current and prognostic state of work processes in the field of innovation, it is necessary to make a choice of managing influences which can subsequently have a positive effect on the production process. At such process of management for realization of a feedback the results of the intellectual analysis of the information/data which are constructed on an estimation of components entering into a complex of the economic information are used.

The results and conclusions obtained as a result of the study, as well as the model of optimization of information support in the field of innovations at high-tech/science-intensive enterprises proposed by the authors can be used in the practice of enterprises when they implement projects due to the organization of competent information support, those groups of processes, which ultimately contribute to the level of competitiveness. The proposed information support cycle of the innovation project can be applied in the organized structure of high-tech enterprises in order to develop effective solutions in the field of management. The methodological tools developed by the authors in the article can find application in higher educational institutions, in the development of specialized textbooks, graduate programs and additional professional education. Scientific novelty is determined by the theoretical substantiation and development of methodological tools for information support of innovative activities to improve the economic efficiency of innovative projects based on simulation modeling with elements of machine learning. As a result of applying the methodology of operational control of the effectiveness of practical implementation of projects in the field of innovation, based on a detailed analysis of economic data, there is a unique opportunity not only to analyze (operational) various groups of information flows, but also to make competent decisions in the field of management based on the principle of information feedback. The application of this principle should actively contribute to the growth of the level of economic efficiency of high-tech/knowledge-intensive enterprise and groups of indicators of its competitiveness.

REFRENCES

[1].Patrushev, V. S., & Popov, V. L. (2021). The mechanism for managing the innovative development of a high-tech enterprise with a full production cycle. *Journal of Applied Research, 2*(4), 30-38.

[2].Coase, R. (1992). The Institutional Structure of Production. *The American Economic Review, 82*(4), 713-719.

[3].Sergeeva, I. A. (2015). Industrial policy and Economic Security of Russia. News of higher educational institutions. *Volga region. Social sciences, 1*(33), 258-267.

[4].Hurwicz, L., & Reiter, S. (2007). *Designing Economic Mechanisms*. Cambridge: Cambridge University Press.

[5].Magomaeva, L. R. (2017). Evolution and classification of information resources as an economic category. *Fundamental research, 7*, 167-172.

[6].Kolbachev, E. B. (2012). Information as the most important economic resource in the development of production. *π-Economy, 1*, 120-127.

[7].Cherkasova, E. M. (2017). Institutional system of factors of production. *Problems of the modern economy, 4*(64), 65-68.

[8].Uskova, T. V. (2019). Key threats to Russia's economic security. *Problems of territory development, 1*(99), 7-16.

[9].Nelson, R., & Winter, S. (2007). The evolutionary approach in economics. *Economics of Education, 3*, 94-96.

[10]. North, D. C. (1990). *Institutions, institutional change and economic performance*. Cambridge: Cambridge University Press.

[11]. Tanenkova, E. N. (2020). The possibilities of measuring institutions and institutional changes in modern economics. *Bulletin of Omsk University. Economics Series, 1*, 45-56.

[12]. Pyzhev, I. S., & Goryachev, V. P. (2018). Implementation of a theoretical approach to assessing the economic efficiency of institutional changes in the industry market. *Terra Economicus, 16*(2), 99-113.

[13]. Orekhova, S. V. (2017). Empirical construction of the institutional map of the Russian metallurgical complex. *Bulletin of the Moscow University. Series 6. Economics, 4*, 73-99.

[14]. Andronova, I. V., Shevchenko, S. Yu., & Osinovskaya, I. V. (2020). Information and methodological support for evaluating the effectiveness of the system of motivation and stimulation of labor. *Natural sciences and humanities research, 3*(29), 43-48.

[15]. Chulanova, O. L. (2014). Grading as a technology for attracting and retaining highly qualified managerial personnel. *Bulletin of Eurasian Science, 5*(24), 158.

[16]. Moroz, A. Yu. (2016). Design of an automated management subsystem in the quality management system of an organization. *Models, systems, networks in economics, technology, nature and society, 2*(18), 47-53.

[17]. Golichenko, O. G. (2012). Main factors of development of the national innovation system. *Innovations, 5*, 4-18.

[18]. Garina, E. P., & Lysenkova, M. V. (2014). CALS-system as a condition for the introduction of modern technologies into domestic production practice as part of the replication of the world's best practices in this field. *Bulletin of Mininsky University, 4*(8), 5

[19]. Britsko, G. V. (2014). Features of the organization of logistics support for the life cycle of complex innovative products. *Bulletin of the University, 12*, 5-11.

[20]. Meshcheryakov, I. G., & Asaul, M. A. (2014). Methodological techniques for the use of organizational innovations of various typological groups. *Bulletin of Civil Engineers, 44*, 213-220.

[21]. Knyazev, S. N., & Gancherenok, I. I. (2007). Management of innovations and innovations in management. *State administration. Electronic Bulletin, 11*, 5.

[22]. Sineva, N. L., & Yashkova, E. V. (2015). Management of the development of intellectual and creative activity of the personnel of a modern organization. *Bulletin of Eurasian Science, 5*(30), 90.

[23]. Ilyakova, I. E., & Loginova, E. A. (2015). The development of human capital as a priority of investment policy in the context of a change in the economic paradigm. *Bulletin of Eurasian Science, 6*(31), 43.

[24]. Polukeeva, A. V. (2015). Features of innovation management of an industrial enterprise. *Organizer of Production, 4*(67), 109-177.

[25]. Shiryaeva, Y. S., Pertseva, L. N., Lapshina, E. N., & Lapshin, E. A. (2017). Some approaches to assessing the innovative development of the enterprise. *Creative Economy, 11*(8), 855-862.

[26]. Yashin, S. N., & Soldatova, Y. S. (2015). Improvement of the system for assessing the sustainability of innovative development of enterprises. *Bulletin of the Nizhny Novgorod University named after N.I. Lobachevsky. Series: Social Sciences, 1*(37), 87-93.

[27]. Chernyakhovskaya, L., Malakhova, A., Nikulina, N., & Ivanova, I. (2020). Simulation Modeling of Innovative Project Management Processes. In *8th Scientific Conference on Information Technologies for Intelligent Decision Making Support (ITIDS 2020)* (pp. 24-29).

[28]. Ershova, I., & Solodiankina, Yu. (2021). Regional human capital development management in the process of globalization. *SHS Web of Conferences, 92*, 02017.

[29]. Nikulina, N. O., Malakhova, A. I., & Ivanova, I. F. (2019). Intellectual decision-making support in the risk analysis of an innovative project. *Design Ontology, 3*(33), 382-397.

[30]. Bakhtizin, A. R., Nizamutdinov, M. M., & Oreshnikov, V. V. (2019). Approach to the problem of strategic management of the regional development based on adaptive simulation model. *Bulletin of St. Petersburg University. Applied mathematics. Computer science. Management processes, 3*, 362-274.

[31]. Samoldin, A., & Susov, R.. (2022). Simulation modeling in digital transformation projects of business processes. *AIP Conference Proceedings, 2383*, 070003.

[32]. Agafonova, A. N., Novikova, E. N., & Shakirov, R. A. (2021). New marketing aspects in the digital economy. In *Digital Technologies in the New Socio-Economic Reality* (pp. 523-529). Cham: Springer International Publishing.

[33]. Borowski, P. (2021). Digitization, Digital Twins, Blockchain, and Industry 4.0 as Elements of Management Process in Enterprises in the Energy Sector. *Energies, 14*, 1885.

[34]. Aamir, T. (2021). Transforming Digital Enterprises Towards Web Scale With Machine Learning. In *Emerging Challenges, Solutions, and Best Practices for Digital Enterprise Transformation (pp. 241-260)*. IGI Global.

[35]. Chernyakhovskaya, L. R., Nizamutdinov, M. M., Oreshnikov, V. V., & Atnabaeva, A. R. (2019). Approach to the organization of decision support in the formulation of innovative regional development

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

strategies based on adaptive-simulation model. *Business Informatics, 13*(3), 20-34.

[36]. Bartczak, K., & Lobejko, S. (2022). The Implementation Environment for a Digital Technology Platform of Renewable Energy Sources. *Energies, 15*, 5793.

[37]. Akhmetova, I., Valeeva, Yu., & Kalinina, M.. (2022). Digitalization of the energy sector: genesis, content, components, evaluation methodology. *Russian Journal of Industrial Economics, 15*, 308-322.

[38]. Valeeva, Y., Kalinina, M., Sargu, L., Kulachinskaya, A., & Ilyashenko, S. (2022). Energy sector enterprises in digitalization program: its implication for open innovation. *Journal of Open Innovation: Technology, Market, and Complexity, 8*(2), 81.

[39]. Dineva, K., & Atanasova, T. (2022). Cloud Data-Driven Intelligent Monitoring System for Interactive Smart Farming. *Sensors, 22*, 6566.

[40]. Gugutishvili, D., Kalyazina, S., & Reiff-Stephan, J. (2022, May). Identification and Classification of the Effects of Digital Transformation on Business. In *Algorithms and Solutions Based on Computer Technology: 5th Scientific International Online Conference Algorithms and Solutions based on Computer Technology (ASBC 2021)* (pp. 391-401). Cham: Springer International Publishing.

[41]. Obukhova, A. S., Kolmykova, T. S., Serebryakova, N. A., Goncharov, A. Y., & Astapenko, E. O. (2022). Trends in digital transformation of the Russian insurance market. In *Imitation Market Modeling in Digital Economy: Game Theoretic Approaches (pp. 46-53)*. Cham: Springer International Publishing.

[42]. Makhosheva, S., & Vasilyeva, E. (2021). Development of business processes in the innovatively active organizations. *E3S Web of Conferences, 244*, 10027.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

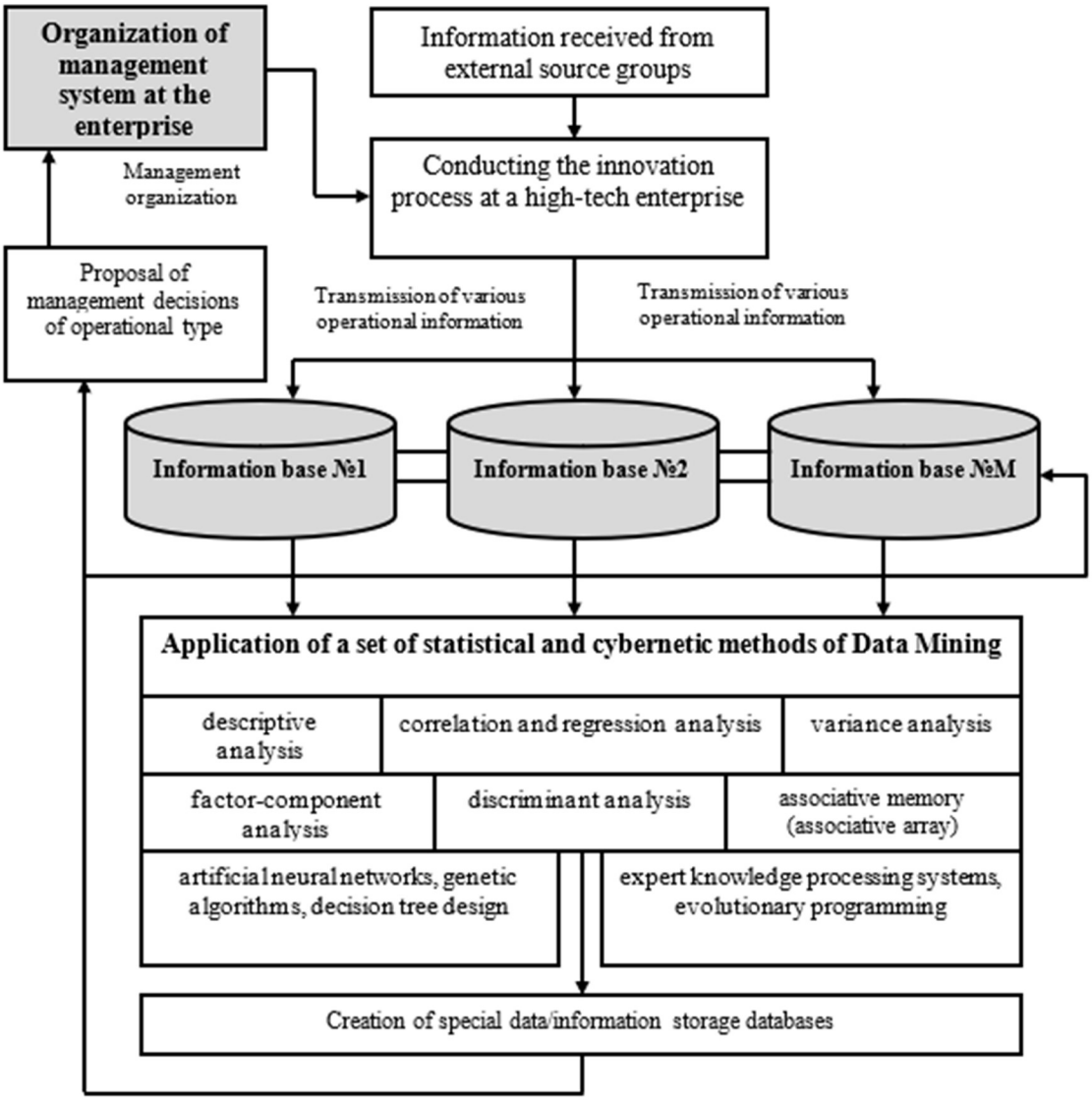

Figure 1: Organization of information system to support the development of solutions in the field of management

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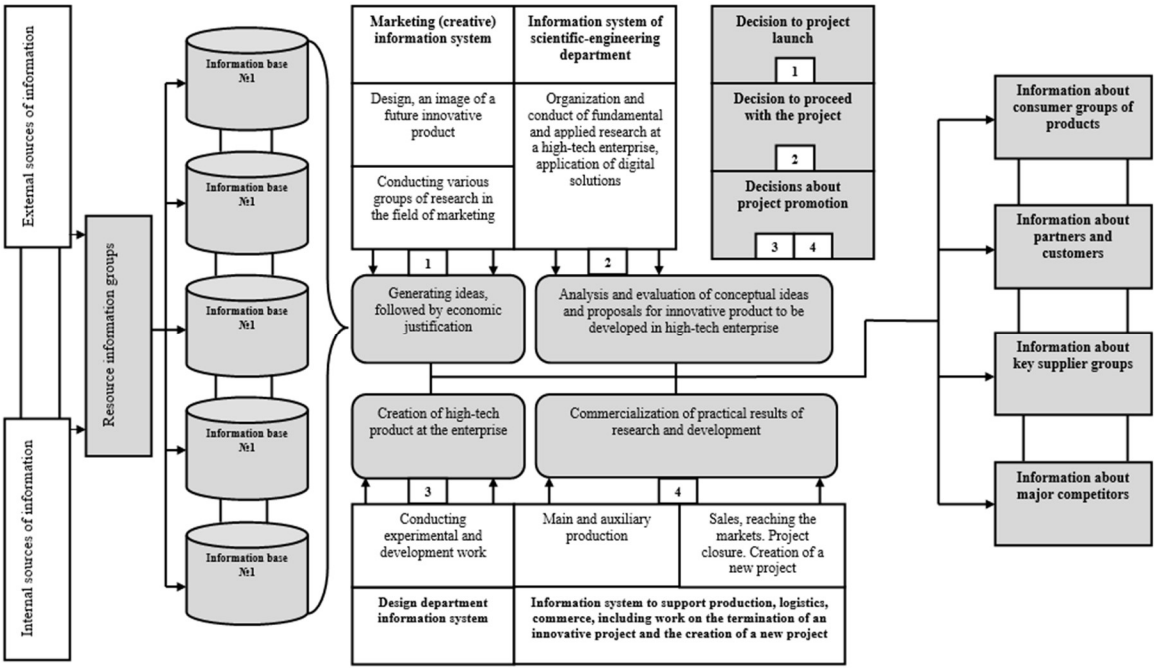

Figure 2: Conceptual mechanism of information activities in the context of the life cycle of inherent product innovation type

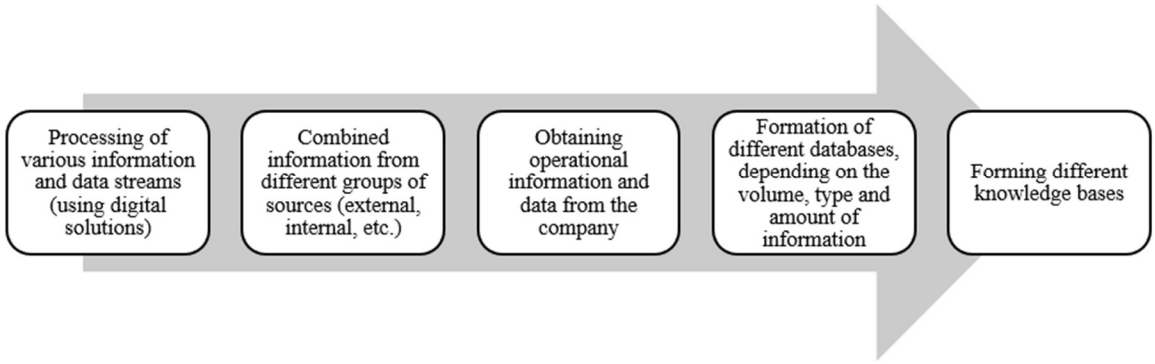

Figure 3: Process of presenting the development of an optimal management solution

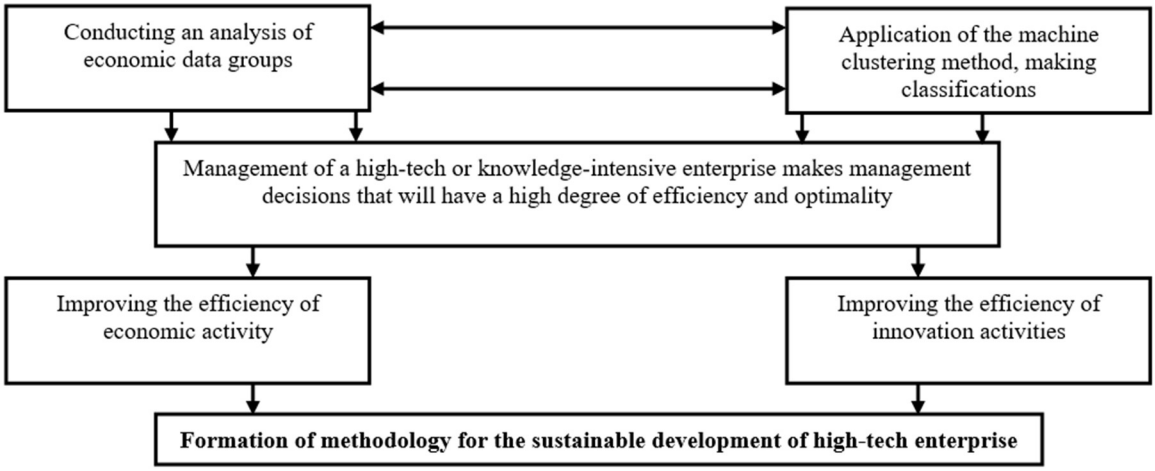

Figure 4: Process of assessing the level of activity of high-tech enterprises in the field of innovation

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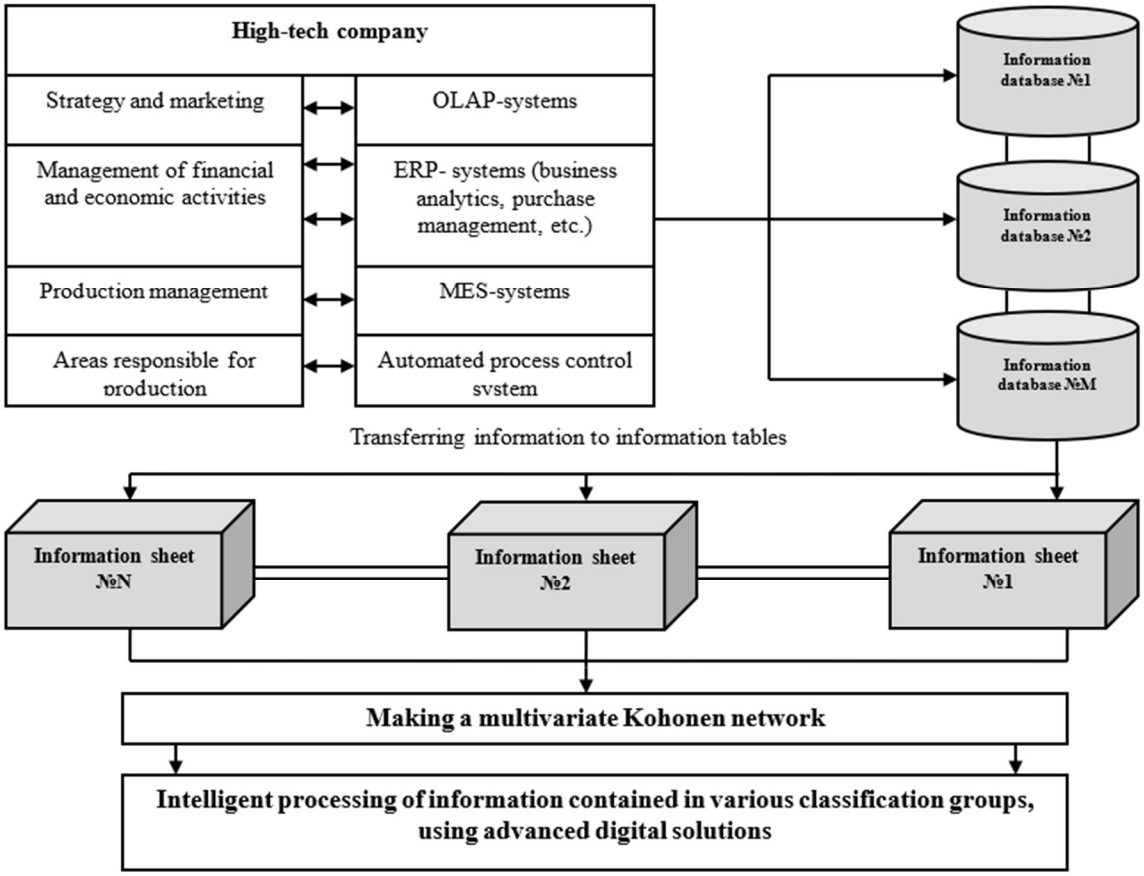

Figure 5: Schematic representation of the methodology for operational monitoring to determine the level of performance of various projects in the field of innovation

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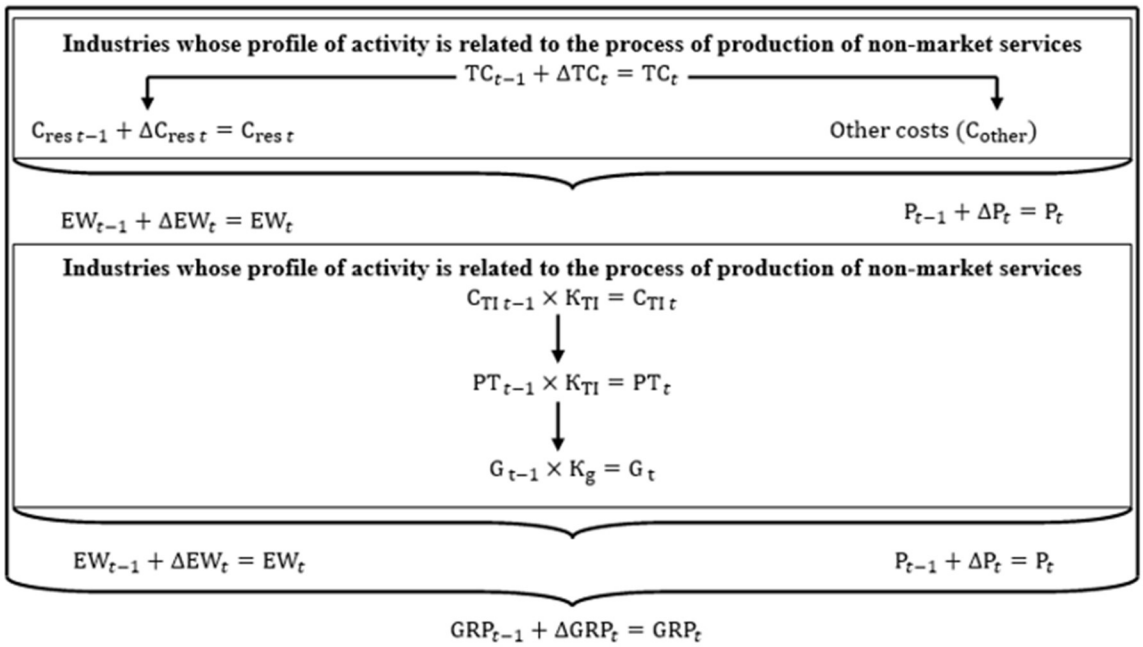

Deciphering the symbols used in the simulation model:
TC is the sum of total costs;
C_{res} is the amount of internal costs attributable to various scientific research;
C_{TI} is the structure of costs attributable to the category of technological innovations;
P is the number of patents filed;
PT is the number of advanced technological developments used and developed by the enterprise;
EW is the number of employed workers (in various scientific studies);
$C_{res\,t-1}$ is the research costs in the previous period
$\Delta C_{res\,t}$ is the increase in research costs;
$C_{res\,t}$ is the research costs in the current period;
GRP is the Gross Regional Product.

Figure 6: System-dynamic model for determining the level of impact of factors on GRP

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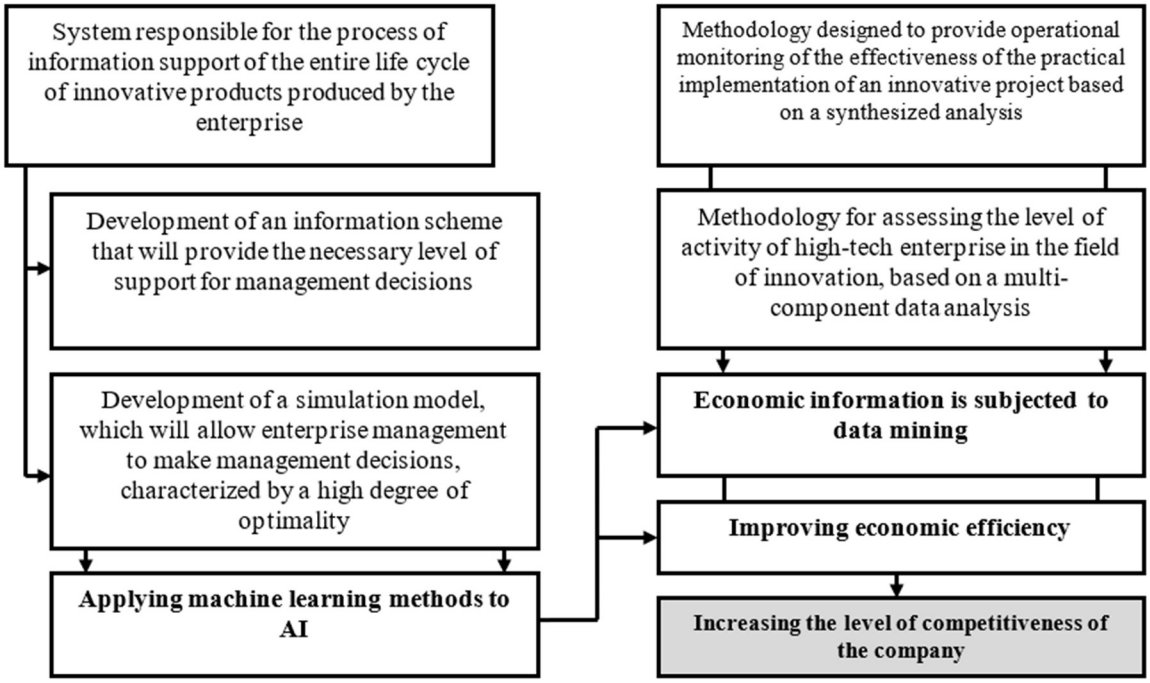

Figure 7: Author's representation of the organizational and economic mechanism in the field of management of various processes in the field of innovation

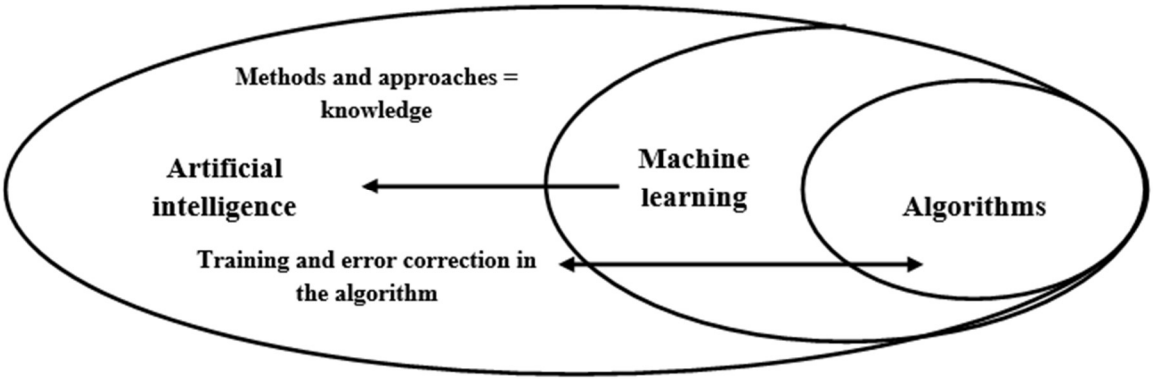

Figure 8: Principle of organizing the relation between machine learning and AI

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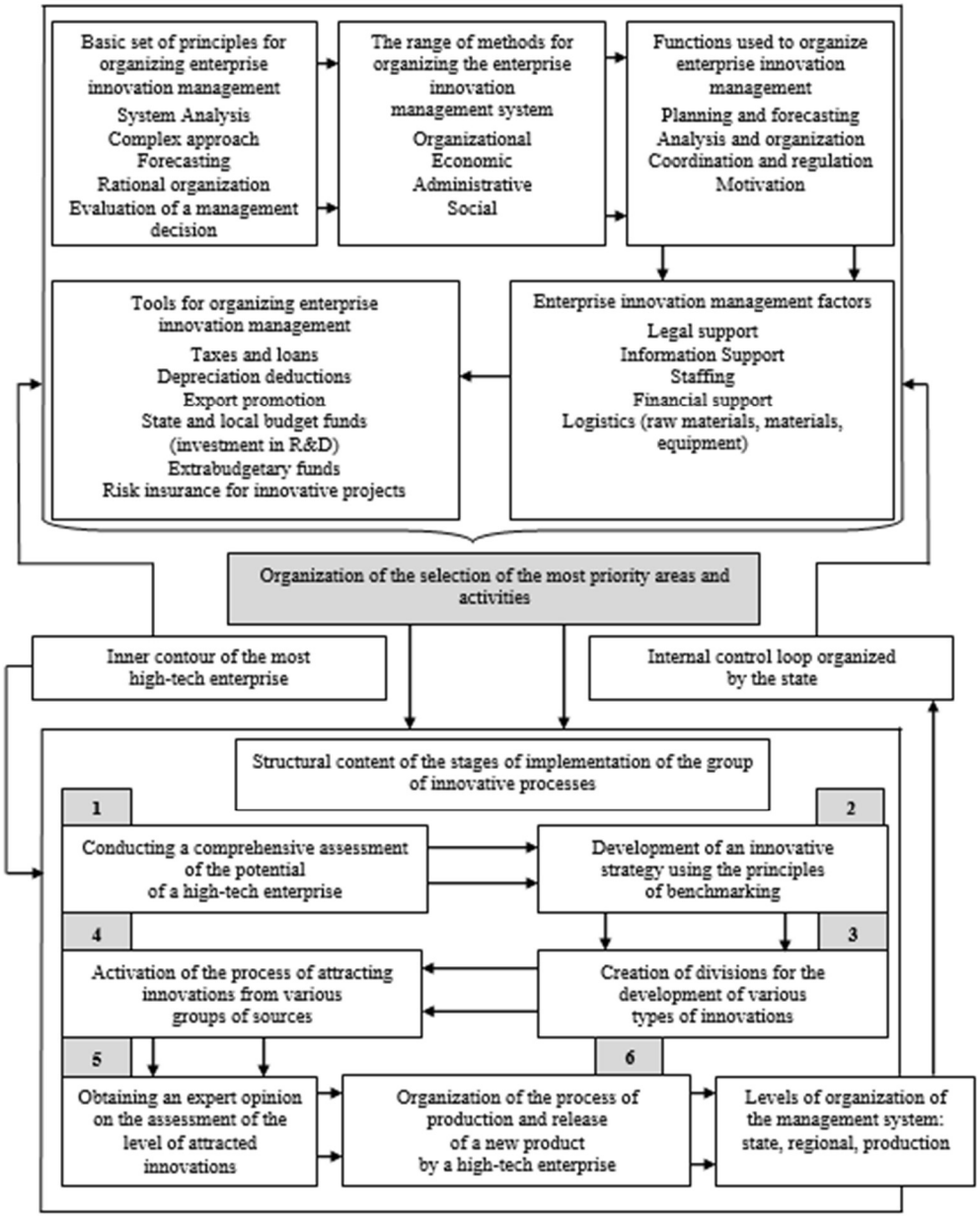

Figure 9: Author's presentation of the scheme of interaction of elements, within the framework of the proposed organizational and economic mechanism for organizing innovation management