

The innovation process effectiveness in the context of management based on information support has been investigated in this study. The task addressed relates to the lack of a coordinated scientific and methodological approach to measuring and assessing the effectiveness of an innovative process, taking into account the role of information support to making effective management decisions.

The study's results include the approach improved to assess the effectiveness of the innovation process by applying SEE management and a structural and logical model constructed to form an appropriate information support, which reflects the relationship between the components of effectiveness.

A feature of this study is the construction of a structural-logical model to form information support for assessing the effectiveness of the innovation process and to build a performance matrix that reflects the relationships between indicators of the enterprise's innovative activity.

The proposed matrix is integrated into the management information system (MIS) and provides increased validity of management decisions. The practical significance of research results is the possibility of using the proposed approach in the management systems of innovative activities at enterprises to increase the efficiency of planning and assessing the effectiveness of innovative processes.

The implementation of the proposed approach contributes to the coordination of strategic and operational goals of the enterprise's development, increasing the adaptability of innovative activities and forming an information basis for making management decisions under the conditions of digitalization of the economy and orientation on the principles of sustainable development

Keywords: *innovation process, performance assessment, information support, SEE-management, comprehensive analysis, sustainable development*

UDC 658.589:65.012.45:330.341.1

DOI: 10.15587/1729-4061.2026.356117

IMPROVING THE PERFORMANCE ASSESSMENT OF INNOVATION PROCESSES IN THE CONTEXT OF SEE MANAGEMENT BASED ON INFORMATION SUPPORT

Inna Vishtak

Corresponding author

PhD, Associate Professor

Department of Life Safety and Safety Pedagogy*

E-mail: innavish322@gmail.com

ORCID: <https://orcid.org/0000-0001-5646-4996>

Nataliia Burennikova

Doctor of Economics Sciences, Professor

Department of Enterprise Economics

and Production Management*

ORCID: <https://orcid.org/0000-0002-2529-1372>

Leonid Maidanevych

PhD

Department of Information Protection*

ORCID: <https://orcid.org/0000-0002-7364-8874>

*Vinnytsia National Technical University

Khmelnitsky highway, 95, Vinnytsia, Ukraine, 21021

Received 12.01.2026

Received in revised form 16.03.2026

Accepted 25.03.2026

Published

How to Cite: Vishtak, I., Burennikova, N., Maidanevych, L. (2026) Improving the performance assessment of innovation processes in the context of SEE management based on information support. *Eastern-European Journal of Enterprise Technologies*, 2 (13 (140)), 52–61. <https://doi.org/10.15587/1729-4061.2026.356117>

1. Introduction

The issues of effective management of innovation processes at industrial enterprises and assessment of their effectiveness under modern conditions are becoming particularly relevant in the context of the transition to sustainable development models and digital transformation of business. The need for transformation of business models using a system of indicators has been substantiated in [1], which emphasizes the importance of information support for the management of innovative changes. Achieving sustainable performance of enterprises largely depends on the combination of innovative activity with digital technologies and effective management mechanisms, which actualizes the need for an integrated approach to innovation management [2]. At the same time, attention is focused on the role of innovations in ensuring environmentally friendly development of industry and increasing the efficiency of production processes, which confirms the importance of improving innovation management systems [3].

Information technologies have changed approaches to innovation processes. The digitalization of industrial (production) processes and the penetration of information technologies into all areas of activity require updated methods for managing innovation processes in the context of management and information support [4, 5].

The problem of ensuring a high level of innovation activity of industrial enterprises is global in nature and is a determining factor in their competitiveness under the conditions of digital transformation of the economy. Limited efficiency of innovation implementation restrains technological development and reduces the ability of enterprises to integrate into global production chains, which makes it necessary to improve approaches to managing innovation processes. To a large extent, this is due to the imperfection of the system for assessing the effectiveness of innovation processes and the lack of effective information support tools for managing innovation activities. In practical terms, this situation leads to the complication of innovation planning processes, irrational

allocation of resources and insufficient justification of management decisions regarding the development of enterprises.

Conducting scientific research in this area is objectively necessary due to the lack of coordinated approaches to measuring, modeling, and assessing the effectiveness of innovation processes in industry. The effectiveness of innovation activity directly depends on the level of integration of technological solutions and economic complexity, which requires developed information mechanisms to support management [6]. At the same time, the effectiveness of innovation is determined by the interaction of organizational learning, flexibility, and innovation, which implies the presence of a comprehensive information environment for making management decisions [7]. The need to use integrated indicators of performance assessment is emphasized in [8], which confirms the importance of a systematic approach to information support. In addition, the role of financial and information tools in ensuring innovative development is emphasized, which indicates the need for their integration into the innovation process management system [9]. However, the issue of a comprehensive combination of modern information systems with models for assessing the effectiveness of innovation processes remains insufficiently developed, which hinders the formation of effective management decisions.

The practical significance of research in this area lies in the possibility of devising scientifically sound methodological approaches to assessing the effectiveness of innovation processes based on a system of indicators of their components integrated into the appropriate models. This makes it possible to increase the objectivity of management decisions, ensure transparency in the assessment of innovation activity, optimize resource allocation, and strengthen the competitiveness of enterprises. The development of the analytical capabilities of the enterprise is a key factor in effective resource management and the implementation of innovations, which enhances the importance of information support [10]. Digital environments and new technologies form new approaches to innovative business models, which actualizes the need for adaptive information systems to support management [11].

At the same time, an integrative approach to combining innovations and sustainable entrepreneurship emphasizes the need for comprehensive consideration of social, economic, and environmental factors [12]. Attention is also focused on the dynamic nature of business models and the need to use indicator systems to assess their effectiveness [13]. In addition, technological transformation in the context of Industry 4.0 requires the integration of innovative, social, and environmental aspects of management [14].

Therefore, the need to improve the theoretical and methodological principles of assessing the effectiveness of innovation processes in combination with the formation of modern information support is due to both the needs of scientific development and the demands of the practice of machine-building enterprises. Therefore, research on improving approaches to assessing the effectiveness of innovation processes at machine-building enterprises based on modern information support is relevant.

2. Literature review and problem statement

In scientific research, there are different approaches to defining the essence of information support. The authors of [15] consider the information support of the innovation

process as a continuous system focused on the needs of different groups of consumers and formed on the basis of economic, technological, social, political, and cultural approaches. Despite the conceptual value of such an approach, the study has significant limitations that reduce its applied significance under modern conditions. The key scientific and applied problem remains unresolved – the development of integrated models that combine information support with the assessment of the effectiveness of innovation processes based on quantitatively measured parameters. This determines the need for further research aimed at forming a methodologically holistic and digitally oriented approach to managing innovative activities.

In [16], the essence of information support as a system-forming element of the innovative development of an enterprise, which forms the basis for making managerial decisions, is defined. At the same time, the study lacks clear approaches to quantitatively assessing the effectiveness of information support and its impact on the effectiveness of innovation processes and does not consider the possibility of integrating modern digital technologies into relevant management models. In [17], the theoretical foundations of the formation of information support in the enterprise management system are considered and the conclusion is reached about its key role in making management decisions. It is noted that increasing the effectiveness of an enterprise in the industry requires improving information support and properly building communication systems. The authors also believe that the formation of information support is a “complex and multifaceted process of providing a convenient and effective form of information exchange both within the enterprise and with the external environment” [17]. At the same time, the study lacks formalization of approaches to assessing the effectiveness of information support, does not define a system of quantitative indicators, and does not disclose mechanisms for its integration with the enterprise’s innovation processes. In addition, the impact of modern digital technologies and analytical tools on increasing management effectiveness is not sufficiently taken into account.

In [18], innovation processes are considered through the prism of management routines and procedures that create value for business. This approach allows us to understand the role of information processes in supporting innovation but does not provide formalized mechanisms for assessing performance.

In [19], an integrated approach to innovation management and product development is proposed, combining technological and business perspectives. However, the work does not focus on information support as a tool for measuring the performance of innovative processes.

In [20], innovation management is associated with the development of partnership relations at the enterprise. The authors emphasize information interaction between the subjects of the innovation process, but do not consider it in the context of SEE-oriented performance assessment.

Thus, our review of the above studies shows that most scientific works consider information support mainly as an organizational, communication, or technological tool for supporting innovation management. At the same time, insufficient attention is paid to the issues of integrating information support with formalized models for assessing the effectiveness of innovation processes. This leads to the fragmentation of approaches to measuring effectiveness and complicates the use of the results in enterprise management systems.

There are differences in approaches to defining the term “information support”. According to the author of [21], “information support is a set of methods, means, techniques, and processes for collecting, processing, summarizing, storing, and using information, which is considered as an innovative component of an enterprise in the innovation management system and innovative work of a modern enterprise”. This approach emphasizes the importance of information resources for ensuring the innovative development of an enterprise. At the same time, the study does not disclose methodological approaches to assessing the effectiveness of information support and its impact on the effectiveness of innovation processes.

Taking into account the opinion of authors in [22] that “the criterion “quantity/quality” should be applied to the effectiveness of any process, and to the innovation process as well, therefore there are a number of unresolved issues. First of all, the category of effectiveness (of the efficiency) of any process according to the final results is subject to consideration simultaneously from both sides. And from the quantitative side, in the form of increment/decrement (increment as an operation of increasing the value of the indicator, in contrast to decrement as an operation of decreasing the value of the indicator) of its large-scale product. And from the qualitative side, taking into account the increment/decrement of the effectiveness (of the effectiveness), and the corresponding indicators as incremental-decremental indicators”, a definition of information support has been formulated. Information support is a set of processes for searching for ways and methods of collecting, digitizing, processing, registering, transmitting, accumulating, and storing information. At the same time, work [22] does not specify the mechanisms for applying incremental-decremental indicators to the assessment of information support, and does not disclose the tools for their integration into the practice of managing innovation processes. In addition, insufficient attention is paid to the issues of adapting the proposed approach to the conditions of digitalization and the use of modern analytical systems.

Summarizing the results of our review of the literature [15–22], it should be noted that modern research sufficiently thoroughly highlights individual aspects of information support for innovation processes, its role in the enterprise management system and its importance for increasing the efficiency of managerial decision-making. Existing approaches mostly focus either on the technological or on the organizational and managerial aspect, without providing a comprehensive combination of information systems with models for measuring the effectiveness of innovation processes.

In addition, the issues of quantitative and qualitative assessment of the effectiveness of innovation processes, taking into account modern conditions of digitalization and the need to take into account the interests of stakeholders, remain insufficiently developed. Existing research only partially reflects the possibilities of using modern information support to form performance management tools, in particular on the basis of the SEE approach.

The generalization of these shortcomings allows us to formulate a scientific problem, which consists in the lack of a methodologically holistic, formalized, and digitally oriented approach to information support, which provides an integrated assessment of the effectiveness of the enterprise’s innovation processes. Solving this task is a necessary prerequisite for increasing the validity of management decisions and ensuring the sustainable development of enterprises under modern conditions.

3. The aim and objectives of the study

The purpose of our study is to improve the approach to assessing the effectiveness of innovation processes at machine-building enterprises on the basis of improved information support using the principles of SEE management. This will make it possible to form an effective toolkit for making strategic management decisions, which will ensure increased efficiency of innovative development of enterprises in the context of digitalization of the economy.

To achieve the goal, the following tasks were set:

- to clarify the essence of the concept of “information support to the innovation process” through the integration of technological and organizational and managerial aspects of the activities of machine-building enterprises;
- to build a structural-logical model for the formation of information support for the needs of managing the effectiveness of innovation processes on the basis of systemic and holistic approaches;
- to propose SEE management stages for quantitative and qualitative assessment of the components of the effectiveness of innovation activity;
- to construct a matrix of the effectiveness of the innovation process as an element of MIS (Management Information System) for visualization and diagnostics of the need to adjust strategic development indices.

4. The study materials and methods

The object of our study is the effectiveness of the innovation process at machine-building enterprises in the context of management based on information support.

The main hypothesis of the study is based on the assumption that the implementation of the SEE-management model based on improved information support would allow for a more accurate measurement of the current effectiveness of innovation processes. This will also make it possible to proactively adjust the strategic vectors of enterprise development through a system of predictive indicators.

Assumptions adopted in the study:

- information support is a dynamic system that integrates the internal resources of the enterprise and external market signals;
- performance indicators have the property of additivity and can be grouped by functional components.

Simplifications accepted in the study:

- external force majeure factors (political instability, macroeconomic fluctuations) are considered conditionally stable during the calculation period;
- the internal organizational structure of the enterprise is considered adaptive to the implementation of new management information systems (MIS).

The study used a complex of general scientific and special methods, such as:

- 1) analysis and synthesis, induction, and deduction – to study the essence of effectiveness and systematize approaches to its assessment;
- 2) generalization method – to formulate the author’s definition of information support;
- 3) systemic, process, situational, and holistic approaches – used to study the structural elements of the effectiveness of the innovation process as a whole;

4) structural-logical and semantic analysis – to develop an algorithm for forming information flows and clarifying the terminological apparatus;

5) comparative evaluation method – to analyze existing metrics (balanced scorecard (BSC), objectives and key results (OKR), X-matrix of Hoshin Kanri) and justify the advantages of SEE management.

The theoretical basis of the study is classical and modern concepts in the field of information systems, strategic management, and marketing. A special place in the work is occupied by models for determining effectiveness, which are adapted for measuring and evaluating specific components of the effectiveness of the innovation process according to the corresponding quantitative and qualitative indicators.

Unlike common tools such as the balanced scorecard (BSC) or objectives and key results (OKR), which require precise (“SMART”) indicators for operational control, the proposed approach is based on the principles of SEE management. It allows one to take into account the nonlinearity of innovation processes and integrate measurement results directly into MIS (Management Information System).

Researchers include in the system for assessing the effectiveness of enterprise functioning such indicators that are based on efficiency as a concept identical to effectiveness, but there are other conceptual approaches [23–25], which we adhere to. The category of effectiveness of any process by final results requires consideration from the quantitative side, in the form of a characteristic of its large-scale product. And from the qualitative side, taking into account efficiency and the corresponding indicators as indicators.

When studying the process, a model of its effectiveness change was used [23]. The scale product K as a quantitative component of performance and the efficiency E as a qualitative component of performance characterize the process from different sides – quantitative and qualitative – simultaneously. Therefore, the measure of performance R can be the product of the corresponding indicators of its scale (final) product and efficiency. The use of a set of indicators in the above models makes it possible to implement in practice a comprehensive approach to management (in particular, SEE-management) of the process under study. SEE-management [23] is a means of increasing the performance of the process in the context of “quantity / quality” based on measuring and evaluating the components of the above-mentioned performance with an indication of possible regulatory actions regarding its change [26]. The triplex “SEE” is composed of the first letters of the lexemes scale (scale), efficiency (efficiency), effectiveness (effectiveness); the order of the letters is explained by the order of calculation of the indicators of scale – K , efficiency – E , effectiveness – R [23]. Information on the results of calculations based on data from industrial enterprises using models of components of the effectiveness of the innovation process can serve as a basis for making an appropriate management decision and requires appropriate information support.

5. Results of investigating the evaluation of the effectiveness of innovation processes in SEE management

5.1. Clarification of the essence of information support to the innovation process in mechanical engineering

Based on the analysis of the current state of Ukrainian mechanical engineering, where only 14% of enterprises demonstrate innovative activity, it was determined that the

critical factor of the crisis is the lack of a holistic information support system. Within the framework of solving the first problem, it was established that the information support to the innovation process is a set of information resources aimed at the development of industrial production through the implementation of the “golden rule of business”. The effectiveness of enterprise management in general and innovation processes in particular increases significantly with thoroughly developed information support.

Effective innovations (from English – *innovation*) and innovation processes contribute to increasing the competitiveness of enterprises, improving indicators of economic, social, environmental, etc. activities and modernization of industrial enterprises in the context of digitalization. They require appropriate information support.

In the Law of Ukraine “On Innovative Activity”, innovations are defined as newly created or improved competitive technologies, products, or services. They also include organizational and technical solutions of a production, administrative or commercial nature that significantly improve the structure and quality of production or the social sphere [27]. The life cycle of innovations, which begins with the birth of an idea, continues with the creation and dissemination of innovations, and ends with use, has time, cost, and labor assessments. Taking into account the sequence of work, the life cycle of innovations is considered as an innovation process.

The innovation process is based on the creation, implementation, and diffusion of innovations, the key characteristics of which are scientific and technical novelty, practical suitability and commercial viability, aimed at meeting new social needs [6, 11–13]. At the same time, the scope of innovations is not limited exclusively to technical and technological solutions. Transformations of management systems and organization of production processes also occur through the introduction of innovative approaches. In particular, new organizational structures, methods of making managerial decisions and incentive mechanisms are developed by the scientific community, improved and implemented similarly to technical means, technological lines, equipment, or information products. New product models, types of services, and organizational forms are the result of innovative processes, the development of which occurs according to a certain logic: awareness of the need for change, formation of goals, development of innovation, its development, dissemination, use and gradual decommissioning.

5.2. Structural-logical model of information support to performance management

The innovation process is considered as a set of sequential actions: idea (search) – research and development (scientific and technical and economic justification of a new product) – technology transfer (experimental testing, bringing to production) – implementation (obtaining a new competitive product). Innovation follows an evolutionary path from the birth of an idea to its transformation into a specific product with further dissemination in the process of practical application. The dynamics of the innovation process, like any complex socio-economic phenomenon, are formed under the influence of the multifactorial interaction of various conditions and prerequisites [1, 4, 11, 13, 14].

Its development is determined, firstly, by the characteristics of the external environment within which it is implemented, in particular, by the type of market, the intensity of competitive interaction, the features of state regulation,

the level of educational potential and forms of integration of science and production. Secondly, an important role is played by the internal state of organizational and economic systems, which includes the availability of financial and material and technical resources, the level of technological development, as well as the nature of interaction with the external environment. Thirdly, a significant factor is the specificity of the innovation process itself as an object of management, which determines the features of its organization, regulation, and assessment of effectiveness [28].

Fig. 1 shows the division of the innovation process into the initial (preparatory) and market parts, which allows us to differentiate the sources of information: from fundamental research to the analysis of market saturation.

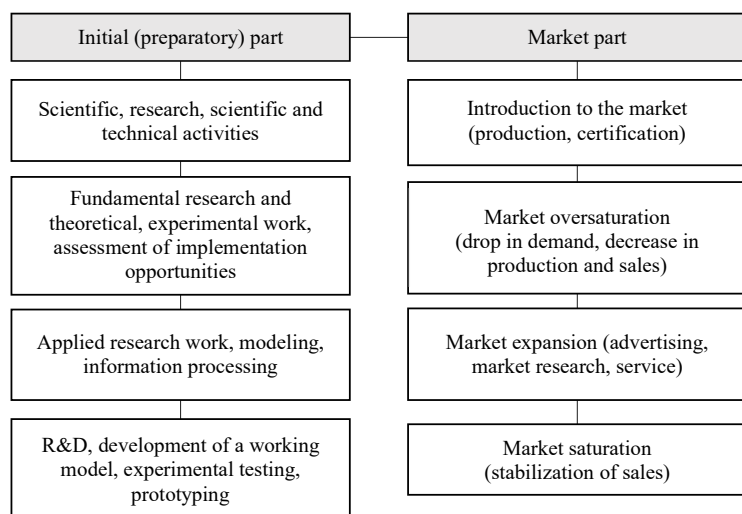


Fig. 1. Main parts (sequential steps) of the innovation process (formed by Authors based on [28])

After the introduction of an innovation, provided that it meets the needs of the market, its effectiveness is usually determined, and the effectiveness of the innovation process is assessed. In this context, in the context of the paradigm of “knowledge-measurement-modeling-evaluation” of the effectiveness of the innovation process for the purpose of its management, the modeling tool has a key role. This requires appropriate information support.

Information support is the main component that enables the adoption and control of the implementation of management decisions regarding innovation processes. In Ukrainian regulatory and legal documents, the concept of “information support” is understood as a complex system that includes regulated document flow, regulatory and legal basis, and methodological approaches to structuring, storing, and representing data within a specific information environment. It includes methodological and instructional documents; a unified system of classification and coding; an information base, which, in turn, is divided into regulatory and reference documents, information messages, and information arrays. That is, in the general sense, information support is a set of structured databases of documents, regulatory framework, implemented decisions, verbal and non-verbal, quantitative, and qualitative information, which is the basis for decision-making. It provides an opportunity to analyze information and transform it into knowledge through systematization and structuring. To characterize the state, problems, etc. regarding innovation processes at the enterprise, it is necessary to

study various information contained in financial statements, forms of state statistical observations, the Internet, and internal documents of the enterprise.

Information support to the innovation process will be considered a set of resources of an information nature regarding the innovation process, aimed at the development of industrial production. The purpose of which is to implement the “golden rule of business”, on the effective functioning of enterprises as complex economic systems. In such systems, resource costs are transformed into optimal income, which aims to identify reserves and risks of economic growth in the management process. Information support for innovative processes must comply with certain principles, in particular, integrity, completeness, reliability, sufficiency, efficiency, integration, complexity, etc. It must include information collection (creation of an information array), information processing (expertise), information interpretation/identification (use of information for decision-making regarding innovations). At the same time, it is desirable to have fairly quick access and protection of such information, which is possible when using the latest technical means and software.

An important element of information support for the management of innovation processes at the enterprise is information technologies. They are a set of technical means, software products, and methods for registering, summarizing, accumulating, processing and using management information in the management process based on the use of software tools of different levels. As is known, the most common information technologies used to build systems for managing innovation processes at enterprises are [29]:

– Decision Support Systems (provides for the construction of a DSS (Decision Support System), based on the formation of a common information base for users, as well as the possibility of joint use by all users of models for solving specific management problems);

– management information systems MIS (Management Information System), where data is collected, processed, and submitted to the manager for operational management; Structured System Analyses and Method (focused on the formation of technical solutions);

– system-functional technology (a certain mechanism for forming a management system as a set of elements that are related by the functions performed);

– process technology (provides for consideration and construction of a system for managing innovation processes from the standpoint of the stages of obtaining, processing, and using management information at the enterprise), etc.

An important requirement when forming information support is the comprehensive collection of data in accordance with the task defined by the management or user. The stages of a comprehensive analysis of the innovation process on the basis of information support are shown in Fig. 2.

Our review of the literature [23–25, 28, 29] and the results of processing the opinions of experts, managers from leading mechanical engineering enterprises in the Vinnytsia oblast, allowed us to build a general structural-logical model of the formation of information support itself. To streamline this process, a structural-logical model of the formation of information support was constructed (Fig. 3), which involves five stages: from defining the object and purpose to establishing cause-and-effect relationships and building the initial document database.

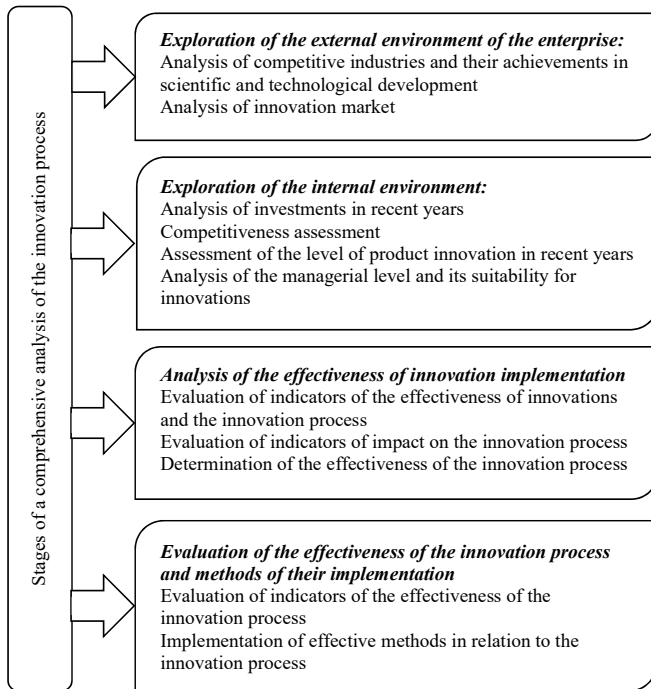


Fig. 2. Stages of a comprehensive analysis of the innovation process based on information support

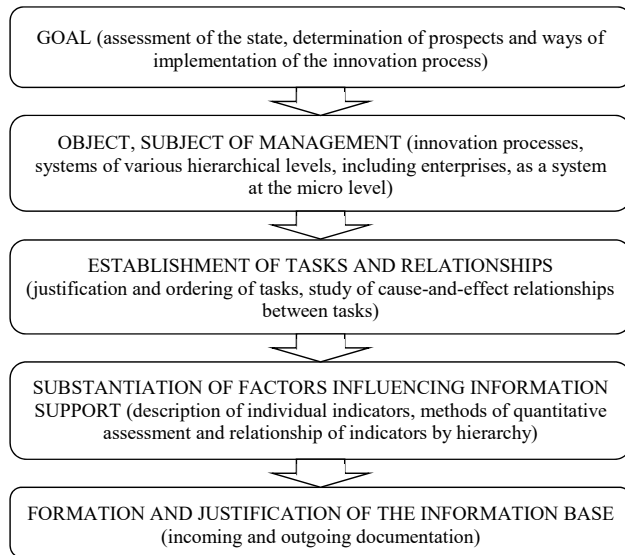


Fig. 3. Structural-logical model of formation of information support for innovation process management (formed by Authors based on [30])

This approach ensures the transition to the use of modern technologies, in particular, DSS (Decision Support Systems) and MIS (Management Information Systems), which creates the basis for a systemic analysis of innovations.

5. 3. Stages of SEE-management to quantitative and qualitative assessment of the components of the effectiveness of innovative activity

Stages of quantitative and qualitative assessment of the components of the effectiveness of innovative activity are based on the implementation of SEE-management (from English – Scale, Efficiency, Efficacy), which is based on the analysis of the effectiveness of the enterprise as a system. Unlike traditional methods, SEE-analysis uses the Burenniko-

va (Polishchuk)-Yarmolenko models to calculate indicators of scale and efficiency through specific algorithms [23].

Stages of SEE-management on the basis of information support are shown in Fig. 4.

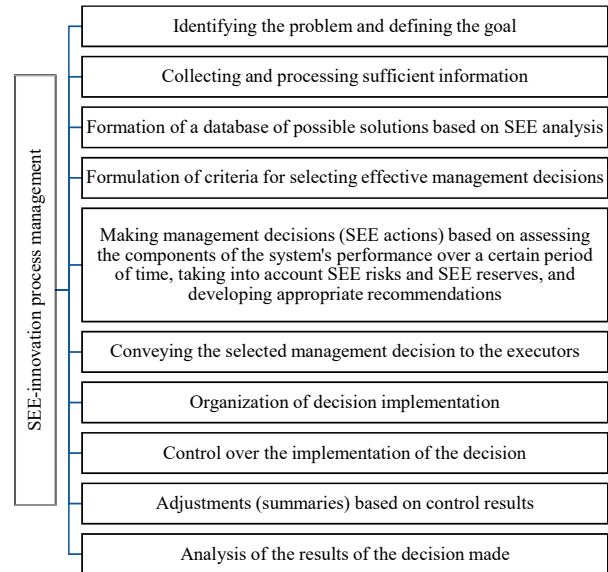


Fig. 4. Stages of SEE-management of the innovation process based on appropriate information support (formed by Authors based on [23, 31])

The process includes data collection, expert processing, and interpretation of results to identify reserves of economic growth. Using this approach allows machine-building enterprises to evaluate not only the final product but also the effectiveness of intermediate stages of the innovation cycle, which is critically important for industries with a long period of R&D (scientific research and development).

5. 4. Construction of a performance matrix as a tool for the management information system

The constructed performance matrix of the innovation process, integrated into the management information system (MIS), is represented in the form of Table 1.

The construction of the matrix was carried out in several stages:

1. Selection of indicators. The scalability index (J_K) characterizes the quantitative results of the innovation process (volume of innovative products, number of implemented solutions, level of market coverage, etc.). The efficiency index (J_E) reflects qualitative characteristics (profitability of innovations, level of technological novelty, resource efficiency, level of risks).

2. Normalization of indicators. To ensure comparability of heterogeneous indicators, linear normalization to the interval [0;1] was applied

$$J = \frac{X - X_{\min}}{X_{\max} - X_{\min}}, \tag{1}$$

where J is the normalized index (J_K or J_E); X is the actual value of the indicator; X_{\min} , X_{\max} are the minimum and maximum values in the sample or according to the standards.

3. Aggregation of indicators. The integral indices J_K and J_E are defined as the weighted sum of the normalized indicators

$$J_K = \sum \omega_i \cdot x_i, \quad J_E = \sum g_i \cdot y_i, \quad (2)$$

where ω_i, g_i are weighting factors determined by expert method or based on factor analysis.

4. Justification of the interpretation scale. The intervals (≤ 0.3 ; $0.31-0.5$; ≥ 0.51) were selected taking into account the principle of uniform distribution of the normalized interval $[0; 1]$; the need to distinguish three management states: critical, stable, and target, and the practice of using similar scales in multi-criteria evaluation.

At the same time, the ≤ 0.3 values correspond to the zone of critical deviations, where the system is inefficient; $0.31-0.5$ – the zone of functional stability, which requires optimization; ≥ 0.51 – the zone of effective functioning, focused on development and scaling.

5. Construction of the matrix (Table 1). At the intersection of the intervals J_K (X-axis) and J_E (Y-axis), 9 quadrants are formed, each of which corresponds to a certain management state and a set of strategic decisions.

to the transition from fragmentary information to its system-matrix interpretation that it became possible to increase the efficiency of management and the accuracy of diagnosing deviations in the implementation of innovative solutions.

A feature of the proposed approach is the integration of performance assessment directly into the management information environment. Unlike traditional tools, such as the balanced scorecard or OKR approaches, which are focused mainly on static target parameters [32–34], the proposed SEE management stages take into account the nonlinearity of innovation processes. This allows us to evaluate not only the results but also the intermediate states of the system in the process of its development. This ensures the adaptability of management under the conditions of digitalization and high uncertainty of the operating environment at machine-building enterprises.

Effective application of the proposed approach is possible under the conditions of the presence of a basic digital infrastructure of the enterprise, integration of information flows between divisions, and use of corporate information management systems.

Table 1

Innovation process performance matrix (original development based on [26])

Scale Efficiency	Low level $J_K \leq 0.3$	Medium level $0.31 \leq J_K \leq 0.5$	High level $J_K \geq 0.51$
High level $J_E \geq 0.51$	«Qualitative Growth» strategy: Resources are scarce, but they are used perfectly. Scaling and investment required	Zone of successful development: Stable growth. It is necessary to support the current dynamics and expand the innovation portfolio	Leadership Zone (Reference): Maximum performance. Success capitalization and technology transfer are recommended
Medium level $0.31 \leq J_E \leq 0.5$	Scarcity Zone: Low power with mediocre quality. Necessary audit of resources and revision of the innovation strategy	Stability zone: Indicators within normal limits. It is necessary to implement measures to improve the efficiency of business processes	Extensive Development Strategy: The process is powerful, but the quality is average. Cost optimization and implementation of Lean technologies are needed
Low level $J_E \leq 0.3$	Critical point (Crisis): There is no effectiveness. Complete restructuring of the process or its termination is necessary	Zone of inefficiency: Sufficient resources are wasted. A change in management and technological approach is needed	High Loss Zone: Large-scale innovation with zero returns. Immediate anti-crisis SEE management is needed

This toolkit provides a visual interpretation of the values for each structural component of performance. The matrix allows management to quickly identify “critical points” – stages of the innovation process where actual indices significantly deviate from target values. This creates a feedback mechanism, where, based on a comprehensive analysis (Fig. 2), management influences are corrected, ensuring the adaptability of the enterprise to changes in the external environment and the digitalization of the industrial sector.

6. Discussion of results based on investigating the effectiveness of innovation processes based on SEE management and information support

Our results consist in the application of a systematic combination of the SEE approach with improved information support for the management of innovative processes. In particular, the proposed formation of information flows (Fig. 2) ensures logical consistency between the stages of the innovation process and management decisions made on their basis. The introduction of the performance matrix (Table 1) made it possible to structure indicators according to the components of the efficiency and quality of the process, which creates a feedback mechanism for adjusting SEE actions. It was thanks

of innovation activities to changes in the external environment and optimize the use of resources in the process of implementing innovation projects.

However, our study has certain limitations. First, the application of the performance matrix assumes the presence of a sufficient amount of reliable data, which may be difficult at enterprises with a low level of digital maturity. Second, the results were obtained under conditions of relative stability of the external environment, which narrows the possibility of their direct extrapolation to crisis or turbulent economic situations. Thirdly, the methodology assumes the adaptability of the organizational structure to the integration of information systems, which does not always correspond to real practice.

Among the shortcomings of the study, one can note the lack of empirical testing on a wide sample of enterprises from various sub-sectors of mechanical engineering, as well as the need to clarify the weighting coefficients of performance indicators depending on the type of innovation. In the future, these shortcomings can be eliminated by expanding the testing base and applying multi-criteria optimization methods.

Further development of the research may be associated with the mathematical formalization of SEE risks, digital automation of the performance matrix, and integration of the proposed approach into management decision support systems. At the same time, there may be difficulties on this

path, in particular methodological (harmonization of indicators of different nature), experimental (accumulation of relevant data), and organizational (readiness of enterprises for the transformation of information infrastructure).

7. Conclusions

1. The essence of the concept of “information support to the innovation process” has been clarified, which, unlike existing approaches, is interpreted as a dynamic set of integrated information resources aimed at implementing the “golden rule of business” within the framework of machine-building production. A qualitative indicator of the result is the transition from a static description of data to understanding information as an asset that transforms resource costs into optimal income. This is explained by the need to take into account the specifics of machine-building as a complex economic system, where management efficiency directly depends on the completeness of identifying reserves and risks of economic growth already at the data collection stage.

2. A structural-logical model of information support formation has been constructed, based on systemic and holistic approaches to performance management. A feature of the structural-logical model is its iterative nature: from the selection of approaches to monitoring the performance components of a separate process. The quantitative expression of the result is the possibility of segmenting the innovation cycle into the initial and market parts, which allows to increase the reliability of management decisions at each stage of the analysis. This result is explained by the logical relationship between the quality of input information and the accuracy of calculating performance indicators in a closed management cycle.

3. The stages of quantitative and qualitative assessment of the components of the effectiveness of innovation activity are proposed, which are based on the implementation of SEE-management. The proposed stages of assessment allow us to simultaneously assess the scale, efficiency, and effectiveness of processes. The quantitative result is to obtain the values of the performance indices, which reflect the degree of achievement of the system’s goals. This is explained by the possibility of mathematically combining heterogeneous factors of innovation activity into a single model, which ensures the adequacy of the diagnostics of the financial and economic condition of the enterprise.

4. The innovation process performance matrix has been built as a basic element of MIS (Management Information System). It is based on quantitatively measured indices; integrates the “quantity/quality” approach; is suitable for automation in digital information systems; is focused on supporting SEE management. The proposed performance matrix allows for the following:

- to carry out rapid diagnostics of the state of the innovation process;
- to identify critical zones (low J_K and J_E) and zones of irrational use of resources;

- to form differentiated management strategies depending on the position in the matrix;

- to implement a feedback mechanism in MIS (Management Information System), which ensures adaptive innovation management.

The peculiarity of the development lies in its visualization ability to diagnose the need to adjust strategic development indices for each division and period separately. The implementation of such a matrix provides a qualitative improvement in management efficiency (up to 15–20% due to the structuring of data flows). The result is explained by the transition from chaotic accumulation of information to its matrix structuring according to SEE-action vectors, which allows managers to instantly identify areas of deviation from a given development strategy.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

Funding

The study was conducted without financial support.

Data availability

All data are available in the main text of the manuscript.

Use of artificial intelligence

The authors declare the use of generative AI in the research and manuscript preparation process. The following tasks were delegated to generative AI tools under full human supervision:

- pre-testing of hypotheses;
- analysis of market trends and/or patent environment;
- grammar editing;
- monitoring of data confidentiality.

Generative AI tool used: ChatGPT, Gemini.

The authors bear full responsibility for the final manuscript.

The generative AI tools are not credited as authors and are not responsible for the results.

Authors’ contributions

Inna Vishtak: Conceptualization, Methodology, Formal analysis, Writing – review & editing, Visualization, Supervision;

Nataliia Burennikova: Conceptualization, Formal analysis, Writing – review & editing; **Leonid Maidanavych:** Validation,

Data Curation, Visualization, Writing – original draft.

References

1. Brunner, M., Gundolf, K., Guieu, G. (2025). From a conventional to a sustainable business model – a review on transformation actions and indicators. *Cleaner Logistics and Supply Chain*, 16, 100258. <https://doi.org/10.1016/j.clscn.2025.100258>
2. Pangarso, A., Yunani, A., Umbara, T., Hendriyanto, R., Sisilia, K., Panutur, S. S. (2025). Uncovering the secrets of sustainable performance: Empirical studies on ethical behaviour, fortitude culture, ambidextrous governance and digital innovation using combined importance-performance map analysis. *Sustainable Futures*, 10, 101181. <https://doi.org/10.1016/j.sfr.2025.101181>

3. Manikandan, S., Vickram, S., Deena, S. R., Subbaiya, R., Karmegam, N. (2024). Critical review on fostering sustainable progress: An in-depth evaluation of cleaner production methodologies and pioneering innovations in industrial processes. *Journal of Cleaner Production*, 452, 142207. <https://doi.org/10.1016/j.jclepro.2024.142207>
4. Huy, P. Q., Phuc, V. K. (2025). Unveiling how business process management capabilities foster dynamic decision-making for effectiveness of sustainable digital transformation. *Business Process Management Journal*, 31 (8), 67–103. <https://doi.org/10.1108/bpmj-06-2024-0467>
5. Li, P., Li, X., Wu, Q. (2025). Digitalization drives Sustainability: How digital trade enhances corporate ESG performance through innovation, internationalization and transparency. *International Review of Economics & Finance*, 101, 104248. <https://doi.org/10.1016/j.iref.2025.104248>
6. Khan, I., Khan, I., Sharif, A., Ahmed, A., Rehman, M. Z. (2025). Advancing renewable energy strategies: Integrating technological innovation and economic complexity for sustainable resource management. *Energy Strategy Reviews*, 62, 101958. <https://doi.org/10.1016/j.esr.2025.101958>
7. Ho, H. X., Nguyen, P. D., Nguyen-Phuong, K.-T. (2025). Fostering sustainable supply chain performance: a mixed-method approach of the moderated mediation model involving learning orientation, innovation, agility, and environmental complexity. *Supply Chain Management: An International Journal*, 31 (1), 122–142. <https://doi.org/10.1108/scm-05-2025-0404>
8. Fernández-Hernández, M., Mora, P., Ortega, M. F., Cabello, J. P. (2025). Development of a comprehensive sustainability index for extractive and mining companies: Integrating the Sustainable Development Goals. *Heliyon*, 11 (2), e41975. <https://doi.org/10.1016/j.heliyon.2025.e41975>
9. Mujie, S., Liu, S. (2025). Fostering energy innovation: Integrating working capital management strategies for sustainability in hydrogen entrepreneurship industries ecosystem. *International Journal of Hydrogen Energy*, 160, 150393. <https://doi.org/10.1016/j.ijhydene.2025.150393>
10. Kristoffersen, E., Mikalef, P., Blomsma, F., Li, J. (2021). The effects of business analytics capability on circular economy implementation, resource orchestration capability, and firm performance. *International Journal of Production Economics*, 239, 108205. <https://doi.org/10.1016/j.ijpe.2021.108205>
11. Latino, M. E., De Lorenzi, M. C., Corallo, A., Petruzzelli, A. M. (2024). The impact of metaverse for business model innovation: A review, novel insights and research directions. *Technological Forecasting and Social Change*, 206, 123571. <https://doi.org/10.1016/j.techfore.2024.123571>
12. Lüdeke-Freund, F. (2019). Sustainable entrepreneurship, innovation, and business models: Integrative framework and propositions for future research. *Business Strategy and the Environment*, 29 (2), 665–681. <https://doi.org/10.1002/bse.2396>
13. Maresova, P., Javanmardi, E., Maskuriy, R., Selamat, A., Kuca, K. (2022). Dynamic sustainable business modelling: exploring the dynamics of business model components considering the product development framework. *Applied Economics*, 54 (51), 5904–5931. <https://doi.org/10.1080/00036846.2022.2055740>
14. Mondal, S., Singh, S., Gupta, H. (2024). Achieving Technological Transformation and Social Sustainability: An Industry 4.0 Perspective. *IEEE Transactions on Engineering Management*, 71, 6623–6635. <https://doi.org/10.1109/tem.2023.3246637>
15. Stadnyk, V., Holovchuk, O. (2017). Scientific and methodical approaches to innovative activity and informational provision management of an enterprise. *Visnyk Khmelnytskoho natsionalnoho universytetu*, 5, 177–181. Available at: <https://elar.khmnu.edu.ua/server/api/core/bitstreams/0955a0bc-feb-4aeb-b0ae-565b3b4a1066/content>
16. Turylo, A. A. (2013). Menedzhment innovatsiynoho rozvytku pidpriemstva. *Visnyk Kryvorizkoho natsionalnoho universytetu*, 35, 278–280. Available at: <http://ds.knu.edu.ua/jspui/bitstream/123456789/3302/1/%D0%A2%D1%83%D1%80%D0%B8%D0%BB%D0%BE%20%D0%90.%20%D0%90.%20%D0%9C%D0%B5%D0%BD%D0%B5%D0%B4%D0%B6%D0%BC%D0%B5%D0%BD%D1%82%20%D1%96%D0%BD%D0%BD%D0%BE%D0%B2%D0%B0%D1%86%D1%96%D0%B9%D0%BD%D0%BE%D0%B3%D0%BE%20%D1%80%D0%BE%D0%B7%D0%B2%D0%B8%D1%82%D0%BA%D1%83%20%D0%BF%D1%96%D0%B4%D0%BF%D1%80%D0%B8%D1%94%D0%BC%D1%81%D1%82%D0%B2%D0%B0.pdf>
17. Zakharchenko, V., Shvahirev, M. (2024). Information Support and its Role in Enterprise Management. *Economics: Time Realities*, 1 (71), 80–86. <https://doi.org/10.15276/etr.01.2024.10>
18. Vala, L., Pereira, R., Caetano, I. (2017). Innovation Management Processes and Routines for Business Success and Value Creation. *Management Studies*, 5 (5), 471–481. <https://doi.org/10.17265/2328-2185/2017.05.011>
19. Cantamessa, M., Montagna, F. (2023). *Management of Innovation and Product Development*. Springer London. <https://doi.org/10.1007/978-1-4471-7531-5>
20. Stadnyk, V. V., Holovchuk, Yu. O. (2020). Upravlinnia innovatsiyamy na osnovi rozvytku partnerskykh vidnosyn pidpriemstva. *Kamianets-Podilskyi: TOV «Drukarnia «Ruta», 232. Available at: https://elar.khmnu.edu.ua/server/api/core/bitstreams/e70878b7-6d25-454e-a600-dbc7ba491f0d/content*
21. Chernoiwanova, H. S. (2018). Information support in the management system of the innovative component of the enterprise. *Naukovyi visnyk Mizhnarodnoho humanitarnoho universytetu*, 31, 58–61. Available at: http://nbuv.gov.ua/UJRN/Nvmgu_eim_2018_31_14
22. Burennikova, N. V., Yarmolenko, V. O., Burennikov, Y. Y. (2021). Effectiveness of the Functioning and Development of Systems: The Updated Approaches to Definitions of SEE-Governance. *Business Inform*, 3 (518), 94–100. <https://doi.org/10.32983/2222-4459-2021-3-94-100>

23. Burennikova, N. V., Yarmolenko, V. O. (2016). SEE-Controlling on the Basis of Components of Efficiency as a Way to Improve the Force of Complex Systems Functioning: Essence, Methodology. *Business Inform*, 1, 145–152. Available at: https://www.business-inform.net/export_pdf/business-inform-2016-1_0-pages-8_14.pdf
24. Khorunzhak, N. M., Portovaras, T. R., Lukanovska, I. R. (2023). Synergism of information from analysis, control and audit for quality management of economic entity activities. *Economics and Law*, 3, 80–90. <https://doi.org/10.15407/econlaw.2023.03.080>
25. Dzhedzhula, V., Yepifanova, I., Kravchuk, Y. (2022). Use of the Theory of Fuzzy Sets in Determining the Level of Enterprise Security. 2022 12th International Conference on Advanced Computer Information Technologies (ACIT), 311–315. <https://doi.org/10.1109/acit54803.2022.9913150>
26. Burennikova, N. V., Kozlov, L. G., Burennikov, Y. A., Zavgorodniy, I. V. (2022). Theoretical Foundations of the Effectiveness of Technology Transfer: Essence, Evaluation, Management. *Business Inform*, 7 (534), 162–170. <https://doi.org/10.32983/2222-4459-2022-7-162-170>
27. Pro innovatsiyu diyalnist: zakon Ukrainy vid 04.07.2002 r. No. 40-IV. Available at: <https://zakon.rada.gov.ua/laws/show/40-15#Text>
28. Marchenko, O., Pustiva, V. (2022). Development of innovative business processes at the enterprise. *Market Infrastructure*, 69. <https://doi.org/10.32782/infrastructure69-17>
29. Smoliar, L. H., Lobodzynska, O. Yu. (2014). Upravlinnia portfelem innovatsiynykh proektiv pidpriemstva. *Naukovyi visnyk Khersonskoho derzhavnoho universytetu. Seriya: Ekonomichni nauky*, 7, 185–187.
30. Korolyshyn, T. V., Myronov, Yu. B. (2015). Providynh informatsiynoho zabezpechennia v innovatsiyniy diyalnosti orhanizatsiyi. *Elektronnyi naukovyi visnyk «Kerivnyk.INFO»*. Available at: <https://kerivnyk.info/2015/02/korolyshyn.html>
31. Yarmolenko, V. O., Burennikova, N. V. (2019). Measuring the Efficiency of the Processes of Functioning of a Component System Based on the Models of the Efficiency Constituents: The Energy Aspect. *Business Inform*, 12 (503), 102–110. <https://doi.org/10.32983/2222-4459-2019-12-102-110>
32. Burennikova, N. V. (2021). Theory and Philosophy of the Effectiveness of Enterprises as Systems: An Updated Look at Ways to Implement Functions and Management. *Business Inform*, 6 (521), 190–196. <https://doi.org/10.32983/2222-4459-2021-6-190-196>
33. Värzaru, A. A., Bocean, C. G. (2024). Digital Transformation and Innovation: The Influence of Digital Technologies on Turnover from Innovation Activities and Types of Innovation. *Systems*, 12 (9), 359. <https://doi.org/10.3390/systems12090359>
34. Plekhanov, D., Franke, H., Netland, T. H. (2023). Digital transformation: A review and research agenda. *European Management Journal*, 41 (6), 821–844. <https://doi.org/10.1016/j.emj.2022.09.007>