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The Instrumental Apparatus of the Innovative Potential Audit of the Enterprise in the Implementation of Project Activities

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Abstract. Innovative development ensures high efficiency and competitiveness in production. However, project activities and sufficient investments are needed in order to encourage innovation. In this way, the relevance of studying the feasibility of project activities in the context of innovative development is growing. This study is aimed at developing tools for auditing the innovative potential of an enterprise, which could be used for investigating the relationships between the dynamics of the innovative potential and the project performance figures grouped by investment categories. The paper examines the impact of project activities on the innovative potential of an enterprise and its innovative position in the industry. The suggested instrumental approach was tested on some enterprises operating in the construction industry. The testing allowed us to rank the enterprises in the industry using open data and to study the relationship between the types of investments made into projects by a particular enterprise and its innovative position. To identify the dependencies, we recommend using correlation and regression analysis. The significance of the approach is in its versatility, since it can be adapted to the conditions of operation in any industry, provided there is sufficient data.

Keywords: Audit activities; Innovation audit; Innovative development; Innovative potential; Instrumental approach

1. Introduction

Project activity (*PA*) is a high-risk field, that entails many difficulties and may not always result in the effects that have been originally planned. *PA* are intended to increase innovation. Innovation makes it possible to enhance the efficiency of production and economic activities and channel production capacities towards a predetermined trajectory (Dvas & Dubolazova, 2018; Gargate, 2018). For an enterprise to be able to conduct *PA* in the context of innovative development, auditing is needed for an independent expert assessment of some elements of business using open data.

With audit activities, the strengths and weaknesses of innovation activities can be effectively evaluated. The analysis can provide sufficient and qualitative information about the potential opportunities and problems of long-term innovative development (Fedotovskaya et al., 2018; Yoon et al., 2015). Since the risk of *PA* is high, we cannot consider

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its effect on the innovative development of the subject in detail. In order to fulfill the key provisions of its innovative development strategy, an enterprise has to carry out *PA* and attract investments to maintain strategic sustainability (Zhu & Wang, 2018).

Thus, the enterprise's innovative potential (*IP*) has to be evaluated and the “determinants of development efficiency” identified in its composition. This identification will help us learn about the problematic elements of corporate innovation (Kajander et al., 2012). The audit of the *IP* can be used for developing approaches to complex problem-solving and improving the company’s development strategy. Consequently, studying the feasibility of PA of the enterprise by evaluating the effectiveness of its innovative activity is extremely relevant. The development strategy determines the number of opportunities to prevent the financing of expensive and potentially unsuccessful projects that can be incorporated in the business entity's innovation policy.

The objective of the study is to develop tools for auditing an enterprise *IP*, that can be used in the audit for identifying the relationships between the dynamics of the *IP* and project performance figures grouped by investment categories. To achieve this objective, the authors examine the impact of *PA* on the *IP*, propose a system of indicators based on open data that can be used for assessing the *IP* of an enterprise, study the possibility of an audit of the *IP* to learn about the relationships between its dynamics and the project performance figures grouped by investment categories.

The research relies on the authors’ studies in the fields of project activities, innovative development, investment analysis, and enterprise economics. The researchers' worldviews and differing opinions ensure a comprehensive look at an enterprise's IP formation processes and determine the trajectories for its innovative growth. The research materials were chosen based on the statement that project activities do not always result in consistent innovative growth, which necessitates the rational use of financial resources through methods aimed at optimizing investment activities and reducing potentially inefficient areas.

1.1. Role of project activities in the formation of innovative potential (IP)

Enterprise management should focus on cost-effective projects so that the strategic goals of the company can be attained. Sustainable growth largely depends on *PA*. *PA* are expected to result in intensive business development, with innovations being essential. This is the way to maximize productivity and reduce costs with minimal capital investment (Burova et al., 2021; Zaytsev et al., 2020b; Donbesuur et al., 2020). At the same time, *PA* are macroeconomically significant because an entity's IP, as well as that of territories, industries, and clusters, is dependent on resource efficiency. The scientific literature highlights that effective *PA* is grounded on “innovative thinking”, whose quality affects the ability to stimulate innovative activity (Kuzovleva et al., 2019).

Traditional approaches to innovative business development define the structure of the IP and highlight its individual elements that should be influenced by management in order to achieve economic growth. Such elements should include human capital, information, business reputation, technology, and other intangible assets of an enterprise (Zheng et al., 2018; Christensen, 2001; Westley & Mintzberg, 1989). The instable innovation environment during the 4th Industrial Revolution can have a negative impact on enterprises that ignore social, institutional, and innovative factors. Low sustainability indicators can keep multi-level structures in a trap of socio-economic failure (Vlasova et al., 2021; Rakhmeeva & Animitsa, 2020; Thoenig, 2016;). Such a threat is explicit for business structures that lack a management system aimed at innovative growth or are not involved in projects that contribute to such growth.

When investing in innovative projects, the rational use of financial resources is essential for maintaining the sustainability and competitiveness of enterprises in all industries. However, researchers note that traditional approaches to choosing innovative projects to be invested in have a number of serious assumptions due to their complexity and focus on classified data, which leads to building new economic and mathematical models (Rodionov et al., 2020; Irani, 2010). *PA* and massive investments can provide a material basis for long-term development. To reduce risks and potential losses caused by them in investment activities, the dynamics of the *IP* should be considered and the efficiency of project investments should be analyzed (Zhu & Wang, 2018).

The transformation of the economic space and its transition from the material to the non-material sphere has resulted in the search for new opportunities to analyze innovation activities. The enterprise *IP* is an integral factor in its sustainable development at all levels of management. In particular, some practical approaches have already been developed to consider the mechanisms that form the market value by introducing changes in the *IP* (Zaytsev et al., 2020a; Stahle et al., 2011; Greenhalgh & Rogers, 2006). The elements of the *IP* can be measured if the overall level of its *IP* is analyzed as well as its sufficiency for carrying out certain types of innovation strategies (Chubai, 2010). *PA* can resolve the problems of potential investment barriers, create new prospects for the R&D of new products, and promote goods on rising markets. However, in order to achieve these objectives, the intellectual capital management system should be seen as extremely important, with massive investment in human resources being needed, which has not yet been highlighted well enough by the scientific community in the context of *IP* reproduction (Dmitriev et al., 2020; Mandych & Bykova, 2019; Roos et al., 2005).

The impact of *PA* on the state of *IP* can be analyzed through a whole range of disciplines such as, mathematics, statistics, cybernetics, and operations research so that the problems related to the efficiency of manufacturing enterprises can be tackled. The techniques aimed at doing so should focus on the best allocation of the limited resources in enterprise investment programs (Colaneri et al., 2021; Demidenko et al., 2018). However, even if an enterprise can conduct a fair commercial assessment of investment projects, problems arise in the external environment due to the non-availability or incompleteness of information. That is why there is need to improve the methodology of financial and economic assessment of innovative projects, given various aspects of their final efficiency (Bril et al., 2018; Sorescu, 2012). One of these aspects is audit, which is suitable for evaluating certain functions of an enterprise using open information.

1.2. Auditing the innovative potential (IP)

The requirements for achieving innovative leadership demonstrate the importance of the efficient allocation of scarce financial resources. The scientific community uses economic and mathematical modeling for allocation and management of finance given investment limitations (Dai et al., 2021; Zaytsev et al., 2021a; 2021c). Auditing is increasingly important in the process of implementing an innovative development strategy by both an individual enterprise and entire industries, given the problems that arise in project finance and in choosing areas for innovative cooperation (Mieke & Specht, 2008). The importance of project investment auditing is becoming even greater due to the contradictions between shareholders and managers, where aggravating conflicts may often lead to irrational *PA*, which is a serious threat to maintaining the sustainability of the *IP* (Zaytsev et al., 2021b; Shadova et al., 2016).

Innovative activity calls for coordinated technical and managerial decision-making processes, whose effectiveness should be considered in terms of their significance for the market. This instrumental significance can be assessed in various ways, for example, on the basis of auditing, which allows us to identify the mechanisms of formation of the enterprises *IP* (Kosenko et al., 2019; Zheng et al., 2009). The Business Risk Audit (BRA) suggests approaches to assessing the potential of innovation based on international auditing standards, but professional and regulatory priorities for determining enterprise *IP* have not been developed (Curtis et al., 2016). The researchers note that the lack of consideration of innovations in *PA* prevents the innovation system from improving. The complexity of innovative development programs is forever increasing, while the identification of complex relationships and patterns makes it possible to improve the quality of project management if we rely on the knowledge system that already exists (Kolomiiets & Morozov, 2021). Thus, audit technology is a promising tool for evaluating the effectiveness of innovations and the efficiency of innovation activities.

Assessing the enterprise *IP* is difficult since information is incomplete and limited. To reduce potential risks, data analytics should rely on the analysis of available financial statements and industry averages. The audit can identify specific interactions and problematic elements of innovative activity in the industry (Austin et al., 2021; Zaytsev et al., 2020c) Auditing is helpful for improving the practice of evaluating innovative activity based on accounting for large amounts of information in the public domain. The information on the efficiency of innovative activity and the problems in various fields can be used for building optimization models of innovative program performance, with the distribution of cash flows between investments (Fedotovskaya et al., 2018). Using this information in auditing supplements the available data on the identified points of innovative growth. The obtained data and the identified qualitative dependencies between the indicators can be used to identify critical problems and suggest solutions (Balagobei, 2018; Yoon et al., 2015).

2. Research Methodology

2.1. An algorithm for auditing the innovative potential (IP) of an enterprise

Auditing the enterprise *IP* is based on the elaboration of an alternative structure of risks and opportunities that may affect its activities. The heterogeneity of the innovative activity of an enterprise complicates the classification of innovations in these structures, which makes a detailed assessment more difficult. Auditing ensures an extensive investigation into the processes in the company, from collecting internal information to analyzing the market and industry. We suggest building a generalized algorithm for the efficiency of the enterprise's *IP* according to the following implementation stages:

1. Analyze the innovative activity: search and analyze the reports and general information, given the specifics of the company's operations.
2. Sort the data: grouping the acquired information into consistent blocks.
3. Explore the possibilities of detailing the innovative activity: check if it is possible to correlate any fragments of information to specific actions.
4. Select the criteria for assessing the *IP*: use indicators for the assessment methodology of the enterprise's *IP*.
5. Assess the *IP* according to the criteria that have been chosen: consider the data obtained in their dynamics.
6. Identify qualitative dependencies: *IP* as a performance indicator.
7. Substantiate the result of the audit and suggest practical recommendations.

This algorithm can help you tackle some problems that are conceptually significant for the enterprise: obtaining information about the efficiency of innovative activity, measuring its contribution to the strategic development of the enterprise; identifying problematic areas based on the controlled parameters that negatively affect innovative development;

justifying the presence of “innovation gaps” (lagging behind the industry average or benchmark indicators of innovative growth).

2.2. Methodology for assessing the innovative potential (IP) of an enterprise

Audit algorithms should consider the need to improve some fragmentary elements of the development strategy, e.g., the financial and economic component, the scientific and technological component, and the investment and value component (selected given the analysis of research from Section 2). The instrumental approach we suggest takes these aspects into account. At the same time, in order to consider these tools, the indicators should be relative and easily adaptable so that different enterprises can be compared to each other by their *IP*, regardless of the enterprise’s size or turnover (selected given the analysis of research from Section 2). It is suggested that weight coefficients be found based on a machine learning mechanism, by analyzing the average industry values of as many enterprises as possible and identifying the normative values of each indicator weight in the industry.

1. Financial-economic component.

Δ Integral indicator of the financial-economic component: $F\&E\Delta = \sum(F\&E_i * a_{1i})$, (1)

1.1. Profit change: $F\&E1 = \frac{P_n}{P_{n-1}}$, (2)

1.2. Profitability change: $F\&E2 = \frac{Pg_n}{Pg_{n-1}}$, (3)

1.3. Revenue change: $F\&E3 = \frac{R_n}{R_{n-1}}$, (4)

1.4. Change in the efficiency indicator of fixed assets: $F\&E4 = \frac{Af_n}{Af_{n-1}}$, (5)

1.5. Change in the efficiency indicator of current assets: $F\&E5 = \frac{Ac_n}{Ac_{n-1}}$, (6)

Designations: P is the profit; Pg is the profitability; R is the revenue; Af is the efficiency of the use of fixed assets; Ac is the efficiency of the use of current assets; n is the current period; a_{1i} *is the weight factor.*

2. Scientific-technological component.

Δ Integral indicator of the scientific-technological component: $S\&T\Delta = \sum(S\&T_i * a_{2i})$, (7)

2.1. Change in the share of intellectual property objects in non-current assets:

$S\&T1 = \frac{Aip_n}{Aip_{n-1}}$, (8)

2.2. Number of patents and copyright certificates relative to the industry average: $S\&T2 = \frac{PCC_n}{PCC(s)_n}$, (9)

2.3. Percentage ratio of new technologies relative to the industry average:

$S\&T3 = \frac{Tn_n}{Tn(s)_n}$, (10)

2.4. The coefficient of implemented innovations: $S\&T4 = \frac{Id_n}{Ii_n}$, (11)

2.5. The share of employees engaged in R&D relative to the industry average:

$S\&T5 = \frac{R\&D_n}{R\&D(s)_n}$, (12)

Designations: Aip is the share of intellectual property objects in non-current assets; PCC is the patents and copyright certificates; Tn is the new technologies; Id is the developed innovations; Ii is the implemented innovations; R&D is the share of employees engaged in R&D; (s) is the sector; n is the current period; a_{2i} *is the weight factor.*

3. Investment value component.

Δ Integral indicator of the investment value component: $I\&C\Delta = \sum(I\&C_i * a_{3i})$, (13)

3.1. Change in the market value of the enterprise: $I\&C1 = \frac{MV_n}{MV_{n-1}}$, (14) 3.2. Change in the investment in R&D: $I\&C2 = \frac{I(R\&D)_n}{I(R\&D)_{n-1}}$, (15)

3.3. Growth in the profitability of innovative investments: $I\&C3 = \frac{I(\%inn)_n}{I(\%inn)_{n-1}}$, (16)

3.4. Change in the value of net assets: $I\&C4 = \frac{V(netA)_n}{V(netA)_{n-1}}$, (17)

3.5. Indicator of investment attractiveness relative to the industry average:

$I\&C5 = \frac{IA_n}{IA(s)_n}$, (18)

Designations: MV is the market value; I(R&D) is the investment in R&D to total investment; I(%inn) is the profitability of innovative investments; V(netA) is the value of net assets; IA is the indicator of investment attractiveness; (s) is the sector; n is the current period; a_{3i} *is the weight factor.*

The integrated indicator of the enterprise's *IP* is calculated by formula:

$InovP = \sqrt{(F\&E\Delta * x_1) * (S\&T\Delta * x_2) * (I\&C\Delta * x_3)}$, (19)

Note: $x_{1,2,3}$ *is the weight coefficient of each component.*

The resulting integral value allows us to determine the qualitative rank of the *IP* of the enterprise for a specific period of time. In case the dynamics are analyzed over a long period, the average level of the *IP* can be calculated, e.g., for 5 or 10 years. It is also possible to rank enterprises in the industry and form the dynamics of the growing *IP* of the entire industry or consider the differentiation of enterprises by territory or by other characteristics. At the same time, the coefficients set for each component can be expanded rather than limited to five indicators. This will require the use of computing technologies that can analytically process large amounts of data.

2.3. Relationship between innovative potential (IP) and project activities (PA)

At the next stage, it is proposed to relate the dynamics of the *IP* of the enterprise with specific *PA*. Econometric tools are suitable for this purpose. We suggest using correlation and regression analysis for identifying the relationships. Then the generalized dependence formula can be represented in the following form:

$InovP = z_i * X_i + const$, (20)

Note: InovP is the integral indicator of the enterprise's innovative potential (resulting parameter); X_i *is the indicator of project activities (controlled parameter);* z_i *is the regression coefficients.*

We suggest grouping the project activity indicators by the following investment categories: X_1 is the investment in human capital; X_2 is the investment in R&D; X_3 is the investment in fundamental research; X_4 is the investment in information capital (information space); X_5 is the investment in information and communication technology; X_6 is the investment in the update (modernization) of the fixed assets; X_7 is the investment in the acquisition of production technologies; X_8 is the environmental investment; X_9 is the social investment; and X_{10} is the investment in high-risk projects and non-core innovations.

In case detailed information on these groups is unavailable, the number of performance indicators can be either reduced or changed. However, for objective industry models, the controlled parameters in the multifactor model should be unvarying for all enterprises. As a result of the innovation audit, a development map of the enterprise is created, and the processes are described in detail. These can be combined into an algorithm of specific actions that have to be taken to achieve the targets.

3. Results and Discussion

We recommend that the proposed tools be tested in the enterprise-related construction sector. We selected 31 enterprises in one region for the analysis. The necessary data were available for them, so the weight coefficients could be formed. 7 enterprises with approximately the same level of assets were selected from the entire set of the enterprises that we studied.

As a result of the analysis of the data from open sources, we were able to calculate the values for each component of the *IP*, given the importance of industry coefficients. The weight coefficients of each component acquired the following values: x_1 (F&EΔ) is 0.2712; x_2 (S&TΔ) is 0.3598; x_3 (I&CΔ) is 0.369. Table 1 presents an example of dynamics for enterprise E1 (values are rounded to hundredths). The approximate annual growth of the *IP* of enterprise E1 amounted to 2.94% over a 10-year period, while the average value of the *IP* for this period was 1.491. Similar calculations were made for a number of other enterprises in the industry. Table 2 considers the main competitors of this enterprise.

Table 1 Values of the components of the *IP* of enterprise E1

Year:	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
F&EΔ	1.17	1.87	2.32	2.83	4.13	4.13	3.97	3.97	3.97	3.97	4.36
S&TΔ	1.52	1.67	2.44	2.25	2.27	1.93	1.89	2.27	2.27	2.27	2.27
I&CΔ	1.98	3.14	4.52	4.70	6.35	6.03	5.49	5.49	4.94	4.45	4.45
InovP	1.17	1.31	1.47	1.49	1.62	1.59	1.56	1.58	1.55	1.52	1.54
Dynamics:	-	12.50%	11.88%	1.40%	8.93%	-1.90%	-2.18%	1.18%	-1.75%	-1.66%	1.00%

Table 2 E1 Values of the *IP* of the enterprises

InovP	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
E1	1.17	1.31	1.47	1.49	1.62	1.59	1.56	1.58	1.55	1.52	1.54
E2	1.11	1.18	1.18	1.32	1.40	1.35	1.26	1.26	1.29	1.32	1.34
E3	1.10	1.07	1.19	1.31	1.41	1.37	1.29	1.36	1.38	1.39	1.38
E4	1.12	1.15	1.18	1.23	1.33	1.31	1.29	1.27	1.29	1.27	1.31
E5	1.16	1.24	1.29	1.38	1.44	1.40	1.37	1.43	1.47	1.46	1.48
E6	1.14	1.17	1.19	1.24	1.34	1.29	1.27	1.31	1.34	1.31	1.37
E7	1.07	1.18	1.30	1.36	1.48	1.43	1.40	1.44	1.48	1.44	1.43
Average dynamics by industry (%)	-	4.54	6.38	5.94	6.01	-3.71	-3.90	2.89	2.51	1.37	1.22

Note: E1 - E7 - number of the analyzed enterprises.

The average annual growth rate of the innovation potential over 10 years is E2 (2.02%); E3 (2.44%); E4 (1.62%); E5 (2.52%); E6 (1.89%); E7 (3.03%). The average value of the innovation potential over 10 years is E2 (1.274); E3 (1.295); E4 (1.250); E5 (1.375); E6 (1.271); E7 (1.364). The absence of abnormal spreads is the evidence of a high quality of the model and the low value of potential errors. The values of the integral indicators for enterprises that are approximately the same in the industry do not differ much. Thus, based on 10-year averaged data, enterprises can be ranked in the industry based on their level of innovation potential: 1st place is taken by E1 (1.491); 2nd place by E5 (1.375); 3rd place by E7 (1.364); 4th place by E3 (1.295); 5th place by E2 (1.274); 6th place by E6 (1.271); 7th by E4 (1.250). At the next step, we suggest exploring the relationship between the types of investments into projects chosen by a particular enterprise and its *IP*. The investments were considered for a number of enterprises, and the following relationship was revealed: $E4 = 0.71 * X_1 - 0.11 * X_5 + 1.25 * X_6$; $R^2 = 0.89$. $E6 = 0.39 * X_2 + 0.07 * X_4 + 0.93 * X_6$; $R^2 = 0.86$. $E7 = 1.71 * X_6 + 1.07 * X_7$; $R^2 = 0.76$.

The enterprises show a high degree of dependence on their *IP* and investments in the updating (modernization) of fixed assets. Enterprise E4 also generates its *IP* through investments in human capital, while investments in information and communication technology have a negative effect. It predetermines the search for ways to revise the investment policy. Enterprise E6 also generates its *IP* through investment in R&D and slightly through investment in the information space. Enterprise E7 also forms its *IP* through investing in the acquisition of production technologies.

We can conclude that by auditing the *IP* during *PA*, the problematic areas of investment can be identified and practical recommendations can be suggested for improving the *PA* of the enterprise with a focus on the sustainable growth of its *IP*, given the economic and value aspects. These aspects can be supplemented by the approaches proposed in the following studies (Zaytsev et al., 2020a; Demidenko et al., 2018; Sorescu, 2012). The significance of the tools suggested by the authors is confirmed by the versatility of the method and the possibility of adapting it to the operating conditions of any industry provided there is sufficient data. Not only does auditing of the *IP* allow us to study the "blind spots" of strategic development, but also the internal opportunities for sustainable growth on the basis of mathematical apparatus. These aspects can be supplemented by the approaches proposed in the following studies (Austin et al., 2021; Yoon et al., 2015; Zheng et al., 2009). The results of the audit are significant to create a foundation for innovations based on rational *PA*.

To make calculations, we have to access the company's reports and statistical data, many of them are freely available. These aspects can be supplemented by the approaches proposed in the following studies (Balagobei, 2018; Curtis et al., 2016; Chubai, 2010). If some sources are unavailable, the criteria for evaluating industry efficiency can be adjusted based on expert assessments or through the mathematical apparatus of similar criteria given the available information. The model we suggest can be used for analyzing the *PA* of an enterprise and identifying the "bottlenecks" of the investment processes in the enterprise. These aspects can be supplemented by the approaches proposed in the following studies (Zaytsev et al., 2021a; 2020b; Zhu & Wang, 2018; Christensen, 2001). The approach we put forward corresponds to the interests of the enterprise in identifying the trajectory for long-term sustainability.

4. Conclusions

This study suggests an instrumental approach to auditing the *IP* of an enterprise. For this purpose, we place an emphasis on the investment component of *PA*. Researchers highlighted that the audit activities should contribute to a prompt assessment of the impact exerted by management decisions about investments on the *IP*, given the scientific, technological, and economic aspects of the enterprise's operations. This practice will largely reduce the risk areas and help rationalize the management practice since the decision-making process will focus on the achievement of sustainable innovative growth. The instrumental approach we suggest has been tested on enterprises in the construction sector, whose *IP* and its dynamics were calculated and identified. The absence of a great spread of indicators over a 10-year period indicates the effectiveness of the authors' model. The approximate growth of the enterprises' *IP* is within the range of 2-3% per year. At the same time, it is possible to rank enterprises in the industry. A key limitation is the need to analyze large amounts of data, which requires using special software and machine learning technologies. An innovation audit will help you understand not only the weaknesses and gaps in innovation management but also elaborate on individual aspects of the corporate growth strategy. For this purpose, regression analysis can be used for developing controlled parameters in a scheme of practical actions that have to be taken to implement *PA*.

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