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организации. Рассмотрено особенности высокотехнологических проектов с целью минимизации проектных рисков и оптимизации параметров эффективности проектов. Представлены элементы механизма формирования высокотехнологического портфеля предприятия.

**Ключевые слова:** портфель высокотехнологичных проектов, минимизация проектных рисков, оптимизация параметров эффективности проектов.

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# INVESTIGATION OF MODERN APPROACHES TO EFFICIENCY ANALYSIS OF THE FUNCTIONING OF CORPORATE INNOVATION SYSTEMS

Проведено дослідження сучасних підходів до дослідження ефективності функціонування корпоративних інноваційних систем, основними серед яких визначено системний, стратегічний та комплексний підходи. Запропоновано методику аналізу інноваційної діяльності та процедуру її інкорпорації в систему управління інноваційними процесами. Визначено функціональні сфери, пов'язані зі створенням інновацій. Розроблено набір показників і критеріїв для проведення моніторингу всіх підсистем, що дозволить визначити реальний стан справ у секторі продукування інновацій.

**Ключові слова:** *інноваційна активність*, *інноваційна політика*, *корпоративні інноваційні системи*, *системний підхід*.

### **1. Introduction**

The application of the system approach to the study of problems of innovation development led to the formation of the concept of innovation systems, which are traditionally explored at the regional and national levels. However, the innovation activity of enterprise is the basis for the effectiveness of the functioning of innovation systems at any level, and accordingly its study should be viewed in the overall complex of management tasks that are strategically important for the formation of the competitive advantages of modern enterprise.

A number of international institutions and agencies annually identify global and industry leaders in the field of innovation. The innovation activity of these enterprises can and should be a guide for the development of others, and therefore requires research in the context of creating the conditions for enhancing and improving the effectiveness of the innovation sector. Especially these issues are important for Ukrainian enterprises, which innovation activities require the introduction of modern management methods.

# 2. The object of research and its technological audit

As an important indicator and condition of innovation the indicator of innovation costs are used, but innovation activity is a complex process, and therefore requires a comprehensive study that would provide an understanding of the nature and patterns of innovation development at the micro level. That is why the development of the methodology for analyzing innovation activities and their incorporation into the management system of innovation processes is topical and has practical importance. The application of the theory of innovation systems in this case will make it possible to present the subject of research in the form of clear algorithms and procedures adapted to the needs of practical implementation.

At Ukrainian enterprises, innovations are still financed by a residual principle, innovation processes are managed on an unsystematic basis, and thus organizational issues and their methodological support require precise regulation.

### 3. The aim and objectives of research

The aim of research is to develop the main stages of the methodology for analyzing the innovation activity of enterprises, which will allow to create a detailed information base of management decisions in the field of innovation in the context of providing innovation processes in Ukrainian enterprises with signs of systemic and sustainability.

To achieve this aim, the following objectives are identified:

1. To identify the main approaches to the study of innovation processes and to ensure their transformation into a practical plane.

2. To develop methodological provisions for the analysis of innovation activities and to ensure its incorporation into the management system of innovation processes.

3. To systematize the main indicators of the analysis of innovation activity of enterprises.

4. To carry out a fragmentary study of the functioning effectiveness of corporate innovation systems of leading enterprises in the automotive sector.

# 4. Research of existing solutions of the problem

Theoretical and practical foundations of the functioning of innovation systems as an organizational and economic mechanism for the activation of innovation processes at enterprises are studied, first of all, in the works of foreign scientists [1-8]. So, in work [1] it is noted that as innovations are more than a science and an innovation system is much more than its elements. For developing countries, the concept of National Innovation System (NIS) has become the ideology of ensuring the bridging of the gap from developed countries. These questions are investigated in [3, 7]. Composition of the elements of innovation systems at various levels is presented in [2]. So far, the concept of NIS has undergone certain changes, which are considered in [4, 5]. The main issues that are disclosed are: the influence of innovation systems on economic growth and the content characteristics of the state's innovation policy.

The formation of directly corporate innovation systems is investigated by scientists in [6-13]. So, in work [8] it is noted that innovations are not only the result of investments in innovations, but the necessary elements are: culture, organizational changes in corporations, that is, system conditions should be created for the formation of an innovativeoriented company. Organizational issues of diversification and internationalization of innovation, commercialization of new technologies through the development of a corporate innovation system are examined in detail in [6]. Unconditional leaders in the development of corporate innovation systems are large enterprises - industry leaders which are able to provide an adequate level of resource support for all stages of the innovation process [13].

Summarizing the conclusions of scientists, it is necessary to emphasize the importance of this issue for Ukrainian enterprises that have not yet become the locomotives of a multi-level innovative development of the country and

require the introduction of an integrated system for managing these processes. The basis for determining effective management decisions to ensure innovative development of enterprises in modern conditions should be a comprehensive analysis of the effectiveness of corporate innovation systems.

# 5. Methods of research

To achieve this aim and certain objectives, general scientific methods of research are used: system-structural approaches to the analysis of economic phenomena and processes, dialectical method of scientific knowledge, analysis and synthesis (in substantiating the essence of corporate structures), systemic generalization (with qualitative characteristics of concepts and theories of corporate governance) and tabular method.

#### **6.** Research results

Innovations have been a key driver of economic development for many decades. The efforts of enterprises, state institutions in many countries are aimed at solving the problem of increasing the level of innovation activity of enterprises, however, significant differences still remain in this area. Thus, innovative enterprises try to maintain their leadership and continue to pursue an innovative policy that ensures the preservation or even expansion of the gap; enterprise-followers direct their efforts to the formation of a critical mass of resources that can ensure their independence in the field of innovation; enterprises-outsiders focus their efforts on increasing the level of the ability to perceive innovations and their implementation in use.

Given such characteristics of the institutional basis of innovation processes within virtually any industry, there is a real need for a clear identification of quantitative and qualitative trends and their accounting in management practice. And because the innovation activity of enterprise is the result of complex innovation processes that require the introduction of targeted management on the basis of a systemic, integrated and strategic approach.

System approach allows to represent the functional areas responsible for innovation activity in the form of interrelated elements.

The application of the theory of innovations at the micro level is embodied in studies of problems of formation, functioning efficiency, improvement of the organization of corporate innovation systems.

The corporate innovation system (CIS) is «a set of participants, activities, resources and units, as well as cause-effect relationships that determine the innovation performance of the corporation» [6].

The result of the functioning of the corporate innovation system should be innovations, which, according to the author [10], are formed in the process of interaction of such elements as: information and knowledge; motivation and stimulation; financial security. This approach, in our opinion, is rather limited, since the managerial component is ignored. That is why the decomposition of the elements of the corporate innovation system should become the basis for determining the directions and objects of the analysis of innovation activity (Fig. 1).



The presented interpretation of the concept and the composition of the elements make it possible to emphasize the multicomponent, functionality and integration of CIS, the main task of which is to provide innovation activity on a systemic basis. Quite often the most innovative active are not those enterprises that spend more money, but those that are able to build a CIS, capable of achieving a synergistic effect on the basis of integration interaction between the elements. Fragmentary CIS is not capable of providing a system innovation development of the enterprise, and therefore only a step-by-step formation of a full CIS will eventually yield a positive result.

Integrated approach determines the need to investigate the enterprise's innovation activity in the overall complex of sustainable development tasks, and not just in the context of innovation process factors. It is also important to take into account the influence of external factors of innovation activity, as well as to determine the general trends in the development of innovation processes in the industry.

A comprehensive study of innovation activity ensures the formation of an information base necessary for the adoption of effective management decisions, the implementation of which is determined by the effectiveness of the functioning of all internal elements which composition allows to identify a systemic approach.

*Strategic approach* determines the need for the formation of long-term innovative goals and the development of innovation strategy, the implementation of which will ensure the direction of all internal functional areas for their full-time implementation.

An important mechanism for implementing a strategic approach to the existing management system of an enterprise should be the process of developing and implementing an innovation strategy, and it in turn will be based on the results of an analysis of the company's innovative activity, which place in the overall system of strategic management is shown in Fig. 2.

Analysis of innovation activity is a key step in the implementation of a strategic approach to the practice of innovation management at an enterprise, for organizational and methodological support of which it is necessary: to define the functional areas associated with the creation of innovations; to develop a set of indicators and criteria for monitoring all subsystems. This will allow to determine the real state of affairs in the sector of innovation development, to determine the level of coordination of the innovation development processes of the enterprise with the trends of technological innovations among competitors in the industry; to study the effectiveness of some or other mechanisms for the formation of innovations and to determine the

critical zones of inconsistencies in the level of innovation activity of the enterprise and its competitors.

Within the framework of efficiency analysis of corporate innovation systems, the following sub-stages are proposed:

1. Determination of directions and objects of analysis. To conduct a comprehensive study of CIS, it is advisable to use the elements shown in Fig. 1. It should pay attention that it is important not only the state of the elements themselves, but also their interrelations, on the basis of which the integrative integrity is formed and the conditions for a synergetic effect are created in the conditions of innovation enterprises.

2. Formation of a set of indicators and criteria for analysis. The one shown in Fig. 1, CIS structure calls for the use not only of quantitative values of economically significant indicators, but also of the criteria for positive changes, and this, in turn, determines the external orientation of the analysis.

3. *Choice of information processing methods*. Different quality characteristics of CIS elements cause the need to apply quantitative and qualitative methods of information processing in the process of analysis.

Thus, the complexity of the analytical study of CIS effectiveness depends on the number of selected indicators, on the possibility of their objective evaluation. The main indicators that can be used in this case are shown in Table 1.



Fig. 2. A place of the analysis of innovation activity of the enterprises in the general system of strategic management of innovations (authors' development)

Table 1

Classification of performance analysis indicators for CIS

Directions of analysis	Type of indicator	Indicators					
Labor resources	Quantitative indicators	1. Number of specialists performing scientific and technical work in general, and their share of the total number of enterprise's employees					
		2. Ratio of full-time employees performing scientific and technical work and those who work part-time					
	Qualitative indicators	1. Initiative and creative activity of employees					
		2. Professional abilities					
		3. Education					
		4. Skill level					
		5. Experience in the implementation of scientific research					
Material	Quantitative	1. Use of new materials, semi-finished products and components					
resources	indicators	2. Dynamics of the share of material costs in general and the cost of energy in the total amount of output production					
Main production means	Quantitative indicators	1. The cost of fixed assets used for scientific and technical work, their share in the total value of fixed assets of the enterprise					
		2. The cost of commissioned fundamentally new equipment, machinery and equipment not related to the expansion of production capacity, and their share in the total value of fixed assets					
		3. The level of mechanization and automation of production					
		4. Computer park (including – connected to the Internet)					
Financial resources	Quantitative indicators	1. The amount of profit aimed at innovation					
		2. The volume of investments aimed at innovation					
		3. The volume of loans aimed at innovation					
Management-	Quantitative indicators	1. The number of subdivisions, functionally related to innovation activities					
infrastructure conditions	Qualitative indicators	2. Organizational support for management decisions in the framework of innovation activities					
	Quantitative indicators	1. The total amount of expenditures for innovation activities, incl.					
		a) expenditures for research and development, namely:					
		– expenses for wages of full-time employees and part-time employees who performed research and development					
Indicators characterizing the level and structure of costs for innovation activities		– capital expenditures for research and development					
		<ul> <li>expenses for the acquisition and manufacture of special tools, instruments, stands, devices, mechanisms and other special equipment necessary to perform a specific topic</li> </ul>					
		- expenses for purchasing «of raw materials and materials, semi-finished products, fuel, energy of all kinds on the side, performed by third parties					
		b) the costs of acquiring new technologies, including the acquisition of exclusive property rights for inventions, utility models, industrial designs, licenses					
		c) the costs of industrial design, other types of production preparation for the release of new products, the introduc- tion of new methods for their production					
		d) expenses for the acquisition of machinery, equipment, devices, other fixed assets and capital expenditures related to the introduction of innovations					
		e) informatization expenses, including: software costs, computer costs, expenses for payment for services of enterprises in the field of information technology					
		2. The structure of costs for technological innovation in the context of sources of financing technological innovation, at the expense of: own, state budget, off-budget funds, domestic and foreign investors, loans, other					
Innovation performance indicator	Quantitative indicators	1. The number of completed developments in general and, among other things, to create new or significant im ments in existing materials, products, processes, devices, systems and methods; Work on creation of prototy products, algorithms and computer programs that have passed expertise for novelty, normative materials, standar					
		2. Applications for protection documents have been submitted and protection documents have been received (including in patent offices of other countries)					
		3. The volume of realized innovative products in general and, in particular, sold outside Ukraine and the CIS countries					
		4. The structure of realized innovative products in the context of the following types: products, has undergone sig- nificant technological changes or is re-introduced, improved products, other innovative products					
		5. The number of new technologies acquired (transferred) by the enterprise, including outside Ukraine, in particular in the CIS countries					
	Qualitative indicators	1. Participation in the implementation of scientific research and development in priority areas of science and tech- nology development					
		2. Thematic focus of research and development					

**Note:** authors' development.

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To partially approbation of the presented algorithm, the formation and efficiency of CIS system functioning are analyzed on the example of Ukrainian and foreign enterprises of the automotive industry. As the basis of innovation activity of the enterprise in modern conditions is change of requirements of the market, innovative leaders set themselves a clear task: to predict the future needs of consumers and turn them into innovation technologies. At the same time, these enterprises send considerable sums for scientific research, increase the number of engineering and technical personnel, apply organizational and economic mechanisms of cooperation to activate innovation activities. The fact that not only quantitative indicators become the object of the analysis allows to determine the influence of various corporate strategies and innovation activity of enterprises by the results of the research.

In addition, the results of innovation activity analysis of the leading companies in the automotive industry presented below (Table 2) indicate that the analysis should be based on as many indicators as possible. tional and management system and a sufficient level of resource support.

Secondly, enterprises have different levels of provision with tangible and intangible assets, and the changes are evidence of innovative transformations. The amount of intangible assets reflects the completeness of the use of the intellectual capital of the enterprise, the achievements of modern scientific and technical progress in the processes of the enterprise. Thus, increase in the value and share of intangible assets, fixed assets is evidence of an active investment policy and priority direction of resources for innovative purposes. The presented data show that intangible assets are of great importance for the development of investigated enterprises, however, by the example of Volkswagen it is clear that their value may be larger for fixed assets.

Thirdly, modern innovators significantly differ both in terms of investment activity and the focus of investments for the renewal of fixed assets and financing of research and development. Especially, these differences can be traced in terms of indicators per employee.

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T	General Motors			Volkswagen			Toyota		
Indicators	2013	2014	2015	2013	2014	2015	2013	2014	2015
Fixed assets, mil- lion USD	25867	27743	31229	56219	60845	56614	69730	73671	77337
Share in assets, %	15.6	15.6	16.1	13.1	13.1	13.1	19.3	18.4	19.5
Intangible assets, million USD	7228	6410	5947	78572	78987	68999	Not revealed in the balance		
Share in assets, %	4.3	3.6	3.1	18.3	17.1	16.0	-	-	-
Investments in BL, million USD	7549	7039	7784	6460	6679	7200	10178	11348	10750
Share in income, %	4.9	4.6	5.1	6.3	5.9	6.1	4.5	4.6	4.7
Investments in the BL per one employed, USD	34470	33046	36294	27370	27126	24661	149676	169373	149305
R & D expenses, million USD	7200	7400	7500	13509	15215	13375	9262	9680	8778
Share in income, %	4.7	4.9	4.9	5.2	5.7	5.6	4.1	3.9	3.9
R & D expenses per employee, USD	33803	34259	34884	23617	25701	21926	136206	144478	121917
The generalized index of innovation activity	0.54	0.52	0.56	0.59	0.58	0.59	0.88	0.87	0.87

The main indicators of innovation activity of the enterprises

Note: authors' development according to data of [14-16].

To calculate the generalized index of innovation activity, the distance method is used, which involves determining the deviation of a set of indicators of the enterprise from the competitor enterprise with better values. Advantages of this method in this case are that it can use an unlimited number of indicators. The results of calculations make it possible to generalize all existing differences in the characteristics of innovation activity and to present them in the form of one relative indicator. Differences in the significance of particular indicators cause significant differences in the values of generalized index of innovation activity. In general, even enterprise-industry leaders have significant differences in CIS effectiveness.

Firstly, the fundamental difference between the functioning of corporate innovation systems in various enterprises is that: market leaders have a well-built organiza-

# Table 2 7. SWOT analysis of research results

*Strengths.* The strength of this research is that the application of modern scientific approaches to the problems of innovation at the micro level has allowed:

Firstly, to comprehensively present the structure of CISs and to determine their main characteristics, which should become the basis for analyzing the effectiveness of their functioning.

Secondly, to justify the mechanism for the incorporation of the procedure for analyzing the CIS effectiveness in the overall system of strategic management of modern corporations.

Thirdly, to highlight the main stages and systematize the main indicators of the analysis of CIS innovation activity.

Fourthly, to carry out a partial testing of the proposed developments in the process of analyzing the innovative activity of automobile manufacturers.

*Weaknesses.* The weak side is that when conducting practical approbation of the proposed methodological approaches to the analysis of CIS functioning, only information from foreign enterprises and a limited number of indicators are used, and the representativeness of the practical part of the study is reduced.

*Opportunities*. Opportunities for further research are the need to introduce strategic management of innovation processes in Ukrainian enterprises. Analysis of CIS functioning that is carried out in accordance with the proposed methodology provides a set of information that is very useful for Ukrainian enterprises, the activation of innovation activity of which should be considered as a condition of survival and the possibility of development.

*Threats.* Threats to research results are that most Ukrainian enterprises continue to solve the problems of operational management and ignore strategically important tasks, which include, first of all, the formation of corporate innovation systems, the basis of which should be the proposed methodology for investigating the effectiveness of their functioning by the example of foreign enterprises, which are active innovators.

## 8. Conclusions

1. An expediency of using system, strategic and integrated approaches in the process of research of innovation processes at the micro level is substantiated. This allowed to present the innovation process at the enterprise in the form of integrative interaction of the elements of the corporate innovation system. At the same time, it is noted that the main CIS components are: external and internal participants of the innovation process, functional diversification, resource support and formation of the institutional structure of the enterprise.

2. An organizational mechanism for the implementation of the strategic approach in the enterprise management system is developed, providing for a number of steps to develop and implement an innovation strategy. The organizational basis of these processes is the corporate innovation system existing at the enterprise, monitoring of the functioning efficiency of which allows to determine the internal potential of the enterprise for activating innovation activity.

3. It is proposed to increase the level of information support for management decisions at the enterprise on innovations by implementation of methodology for analyzing the effectiveness of CIS functioning, within which the stages of analysis are proposed, the existing indicators are systematized, an integral index of innovation activity is developed.

4. The conducted study of innovation activity level on the example of foreign enterprises of the automotive industry makes it possible to present their results in a fragmented and generalized form, and this, in turn, makes it possible to establish differences in the content, organizational and quantitative characteristics of existing corporate innovation systems.

The presented developments establish rules, procedures, subsystems and, as a whole, a policy on innovations at a particular enterprise. The application of strategic, systemic and integrated approaches to the management of innovation processes will allow in practice to formulate clear guidelines for innovation development, to formulate an effective algorithm for their achievement, to overcome the lag behind industry leaders in key indicators.

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#### ИССЛЕДОВАНИЕ СОВРЕМЕННЫХ ПОДХОДОВ К АНАЛИЗУ Зффективности функционирования корпоративных инновационных систем

Проведено исследование современных подходов к исследованию эффективности функционирования корпоративных инновационных систем, основными из которых определены системный, стратегический и комплексный подходы. Предложена методика анализа инновационной деятельности и процедура ее инкорпорации в систему управления инновационными процессами. Определены функциональные сферы, связанные с созданием инноваций. Разработан набор показателей и критериев для проведения мониторинга всех подсистем, что позволит определить реальное состояние дел в секторе выработки инноваций.

**Ключевые слова:** инновационная активность, инновационная политика, корпоративные инновационные системы, системный подход.

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