Adaptive Management of Innovative Development of Enterprises in the Conditions of Digitalization and Actualization of the Lean Approach

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Abstract

In the article, features of adaptive management and characteristics of using the lean approach to enterprise management are determined, which made it possible to determine the main tools to implement the above approach. Principles and goals of implementing the lean approach to optimize activities of enterprises are analyzed. Tools of adaptive management based on the lean approach are substantiated. Modern trends in innovative development of enterprises in EU countries are analyzed. Based on the survey of enterprises regarding their innovative development, key factors influencing development of innovations, main obstacles and problems are identified. The dynamics of the employees involved in innovative developments in Ukraine in the period 2010-2023 was analyzed. Based on the study of the current state of digitalization and innovative development, the conceptual scheme of organizational and economic mechanism is proposed. Based on isolated components of the mechanism, its components were defined, which, unlike existing ones, consider adaptive capacity and flexibility of enterprises to the external environment.

Keywords: Adaptive Management, Lean Technologies, Optimization Of Production Processes, Business Process Efficiency, Continuous Improvement, Quality Management, Productivity Of Remote Employees, Flexibility, Innovative Development, Digitalization.

Introduction

Development of digital technologies in all areas of production requires new approaches to managing innovation processes at enterprises. Lean technologies, optimization and efficiency, adaptability, continuous improvement, quality management, monitoring productivity of remote employees, flexibility, etc. play an important role in these processes. In conditions of high uncertainty and unfavorable security in the country, most enterprises are forced to adapt to these conditions for functioning and development. Uncertainty of the external environment requires enterprises to be flexible in decision-making, which is ensured by available appropriate resource base.

In difficult economic and security conditions, some enterprises in Ukraine have lost their adaptive capacity due to destruction of production facilities, temporary occupation of their territories, forced relocation to other regions of the country, which has affected the established supply chains. Therefore, enterprises are facing new challenges related to implementation of innovative technologies that will allow businesses to acquire necessary adaptive capabilities to counteract risks and threats from the external environment and ensure appropriate level of competitiveness in the long term.

In these conditions, management practices based on lean production are developing, since it is precisely through introduction of innovations and digital technologies that the need for the human factor in production is significantly reduced, which determines relevance of the study.

Literature Review

Rapid development of digital technologies and market volatility require enterprises to be adaptable and innovative. Adaptive management allows organizations to implement new solutions and optimize processes. The update of lean principles in combination with adaptive management allows enterprises both to maintain competitiveness, and to implement new solutions, optimize business processes and increase resilience to external challenges.

Babenko V. et al. (2017) analyze risks in the enterprise's innovation development management system, which will mean factors that negatively or catastrophically affect productive processes. Lesiv I. et al. (2025) analyze adaptive management systems to improve efficiency of the manufacturing enterprise. Sheth et al. (2024) propose the industry-agnostic list of plausible risk factors using information extraction from large-scale text data. Authors propose innovative comprehensive network view of corporate risks that reflects small-world properties and highlights internal functions of the company. Pronoza P. et al. (2024) substantiated the need to introduce financial controlling tools into the adaptive management system. Tulchynska S. et al. (2021), Nikiforov P. et al. (2022) propose development of innovation and investment strategies aimed at activating potential of the enterprise and establishing cooperation between business and the state.

Saah P. et al. (2024), Kondratenko N. et al. (2024) justify feasible creating of clusters and improving management practices to maintain competitiveness and maximize adaptation to changes in the national economy. Rokytro T. et al. (2023) proposed the author's scientific approach to determining main parameters, areas of activity and principles of integration into the European economic, political and socio-cultural space. Authors analyzed adaptation problems in the European integration context.

Druhova O. et al. (2025), Pravdyvets O. et al. (2024) outlined strategic directions, considering existing restrictions in martial law conditions.

Iastremska O. et al. (2024), Roieva O. et al. (2023), Maranzana S. et al. (2024) analyzed strategic perspective and lean practices used in industrial enterprises, and assessed the expected benefits and efforts associated with their implementation.

Stronczek A. (2023) analyze barriers to implementation of lean accounting. Jasti N.V.K. et al. (2021) propose to investigate the Lean excellence framework in Indian manufacturing industry using interpretive structural modeling and structural equation modeling. Authors prove that for successful implementation of the Lean framework, the appropriate strategy is required, which was developed by authors within the study.

Cherrafi Anass et al. (2020), Oliveira Gilson Adamczuk et al. (2018) analyze application to develop new products in the context of increasing their efficiency. Jing Shuwei et al. (2017) adapted the method of applied enterprise research, focusing on the enterprise personnel management and finding key driving factors for lean production.

The outlined problems of innovative development of enterprises require further research with the emphasis on adaptive management, digitalization, and modern lean approach.

Purpose of the article is to study features of adaptive management of innovative development of enterprises within digitalization and actualization of the lean approach.

Results

Ensuring competitive advantages in modern business conditions is associated, first of all, with ability to adapt to highly variable external environment. The enterprise should be considered as a single system, in this case the peculiarity of the adaptive system is ability to change in response to external and internal transformations of the parameters of their functioning. In this direction, research distinguishes the “adaptive management” concept. In activities of enterprises, relevence of adaptive management increases in the following situations:

first, during the period when the enterprise emerges from the crisis;

second - when introducing innovations into activities of enterprises;

third, during organizational changes at the enterprise.

The main goal is to ensure flexibility, the ability to adapt to new conditions, while maintaining efficiency. The main difference between adaptive management and traditional management is flexibility and rapid response to changes with minimal resource consumption and maximum efficiency of their use. Main tasks of adaptive management are to find options for making theoretical and practical measures for implementing the management system directed to stabilizing situation of the enterprise, assessing adaptability of the management model. The Lean approach is currently actively used, which is aimed at optimizing production to reduce losses.

It is integrating the lean approach and digital technologies that allow for effective resource management, cost reduction and productivity improvement. Flexible management techniques facilitate rapid response to market challenges and ensure sustainable development of enterprises in the digital age. The lean approach itself was developed by Tahiti Ohno to optimize Toyota production, which contains seven loss positions, namely: overproduction, excess inventory, excessive transportation, unnecessary movements, waiting, excessive processing and defects.

Seven listed items take into account losses that occur in production, regardless of the type of economic activity and ownership. By influencing these losses, the enterprise can optimize production processes, which will positively affect the enterprise's profit and increase production efficiency.

The main goal of using the lean approach is to increase business efficiency by eliminating all types of losses (surpluses, downtime, defects, shortages) while creating value for customers. The main vectors of using this approach are aimed at:

- customer orientation, by determining what is valuable to him from the consumer's point of view;
- identification of value streams based on the analysis of each stage of project implementation to identify losses;
- flow, which characterizes construction of continuous flow of processes without delays and downtime;
- production pull (Pull system) which characterizes the need to produce products only in response to corresponding demand for them;
- striving for perfection (Kaizen) through continuous production improvement.

Peculiarities of using this approach are due to its flexibility and adaptability, since it can be used in any industry. It is important to involve the entire project team in improving management processes at all stages, allowing employees to feel their significance regardless of their position and professional responsibilities.

To improve business processes, it is advisable to use modern tools (5S, Kanban, Value Stream Mapping, Poka-Yoke, JIT (Just-In-Time), which allow expanding variable use of directions for improving these processes (Table 1).

Table 1 – Basic tools of adaptive management based on the lean approach

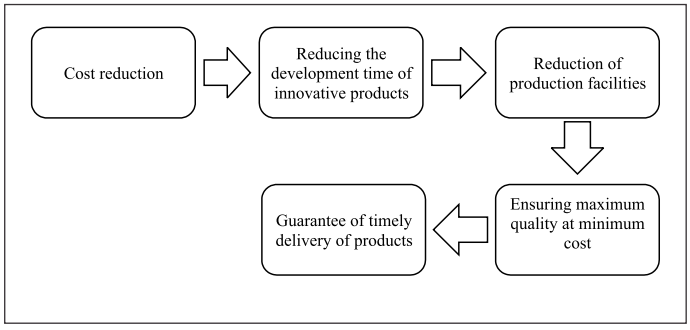
Tool	Essence
"5S" workplace organization methodology	Aimed at improving efficiency, order and safety, it consists of five Japanese words: Sorting (Seiri) – separating what is needed from what is not needed. Systematization (Seiton) – ordering the necessary. Cleaning (Seiso) – maintaining cleanliness. Standardization (Seiketsu) – reation of standards. Compliance (Shitsuke) – discipline and self-discipline.
Kanban	Visual process and task management system that allows you to see the status of work at each stage. Often used in the form of the board with columns "Planned", "In progress", "Completed". The main idea is to limit number of tasks in the work to reduce overload and increase productivity
Value Stream Mapping (VSM)	Value stream mapping is a tool for analyzing and optimizing all stages of manufacturing the product or providing the service. It allows you to identify losses (time, resources), depict the current state, and design a future, more efficient state of the process.
Poka Yoke	Error protection system. These are simple and effective mechanisms that prevent human errors or instantly detect them. For example, the design that prevents a part from being inserted incorrectly, or automatic error notification
JIT (Just-In-Time)	Just-in-time is the approach to manufacturing in which raw materials, components, or products are delivered only when they are actually needed. The goal is to minimize inventory, reduce costs, and avoid overproduction.

Source: summarized by the authors

Using these tools for the enterprise in the context of innovative development has certain advantages. Implementation of the lean approach helps increasing the focus of employees on achieving common goal of the company. The main goal is to create maximum value for the client, which requires employees to be flexible and creative in making decisions. Innovative and digital technologies affect increase in labor productivity due to clear delegation of authority and tasks, which allows avoiding misunderstandings in the team. Focusing on consumer needs allows you to significantly reduce losses by reducing unnecessary production operations, which significantly saves resources. Adaptation of all production processes is significantly improved due to structuring of tasks, correct distribution of areas of responsibility, and coordinated work of the team.

The main objective of using the lean approach is its long-term perspective in improving lean production. Summarizing the above, it is possible to formulate main goals of implementing the lean approach in innovative development (Fig. 1).

Figure1. Objectives of implementing the "lean approach"



Source: summarized by the authors

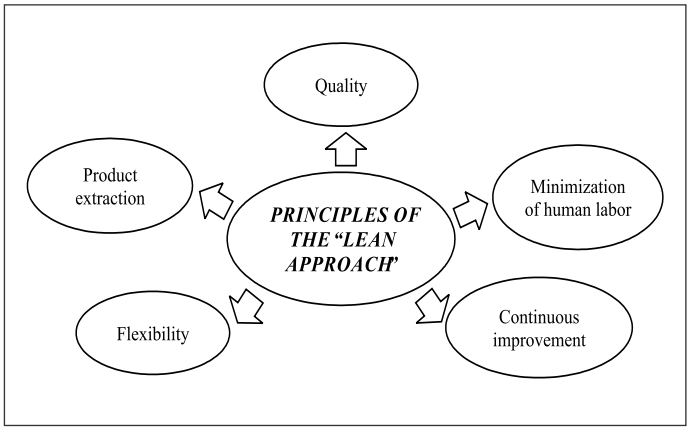
Ensuring implementation of the established goals of the lean approach is carried out based on using relevant principles of the lean production. If we consider these processes by introduction of innovative developments into activities of enterprises, then direction of its use will be, first of all, intellectual and human resources, since it is the personnel that play the key role in development of innovations.

Important role is played by production systems in the lean approach, which are focused not only on eliminating losses, but also, on continuous improvement of all production

processes at all levels of management. At the same time, all work is aimed at long-term development of the enterprise, making profit and achieving the goal, short-term financial goals are not a priority task. At the same time, the peculiarity of management control is the timely identification of problems and their effective solution, and not the use of methods of constant assessment of employee efficiency.

Considering development vector of the lean approach, it is advisable to highlight main principles of its application (Fig. 2).

Figure2. Basic principles of the "lean approach" to innovative development of enterprises



Source: summarized by the authors

Development of adaptive capacity of innovative development of enterprises is oriented towards market needs, taking into account technologies digitalization, which requires flexibility in decision-making. These properties can be attributed to the behavioral component of innovative development of enterprises, which, in addition to flexibility and adaptability, may also include activity. Behavioral properties characterize behavior of the enterprise in competitive environment according to the following properties:

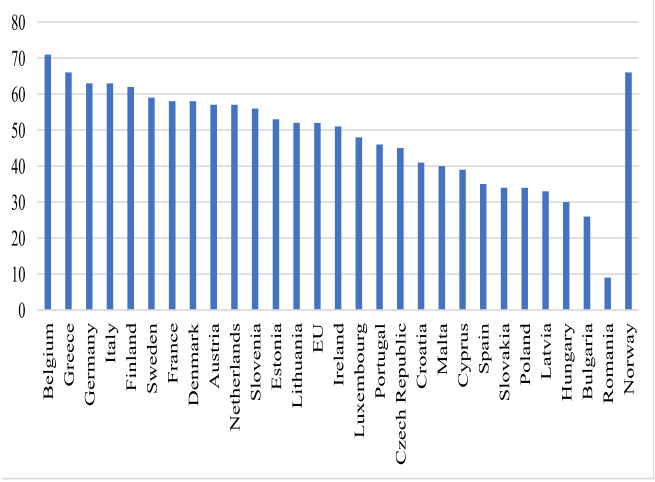
— activity that determines ability of the enterprise to interact with external counterparties and implement its functions;

—flexibility, which characterizes ability of the enterprise to respond in a timely and effective manner to changes in the external environment;

— adaptability characterizes ability of the enterprise to quickly change its internal environment in response to changes in the external environment, which allows the enterprise to carry out its activities.

At the same time, principles of the lean approach form the conditions for implementation of behavioral and other rapid innovative development of the enterprise in the context of digitalization. The quality principle assumes long-term focus on meeting consumer needs while maximally producing the quality product or service, taking into account cost optimization. The principle of continuous improvement applies not only to production of goods and services, but also includes development of management and production processes. Minimizing the use of human labor has double meaning, because on the one hand, for enterprises this is positive aspect, since it allows significantly reducing labor costs, speeding up operations, minimizing negative impact and risks on hazardous production operations. On the other hand, in the social aspect, a significant number of people are released who need employment or improving their skills to maintain their competitiveness in the labor market. Figure 3 shows the share of enterprises with innovation activity during 2020 - 2022.

Fig. 3. Share of enterprises with innovation activity, 2020-2022



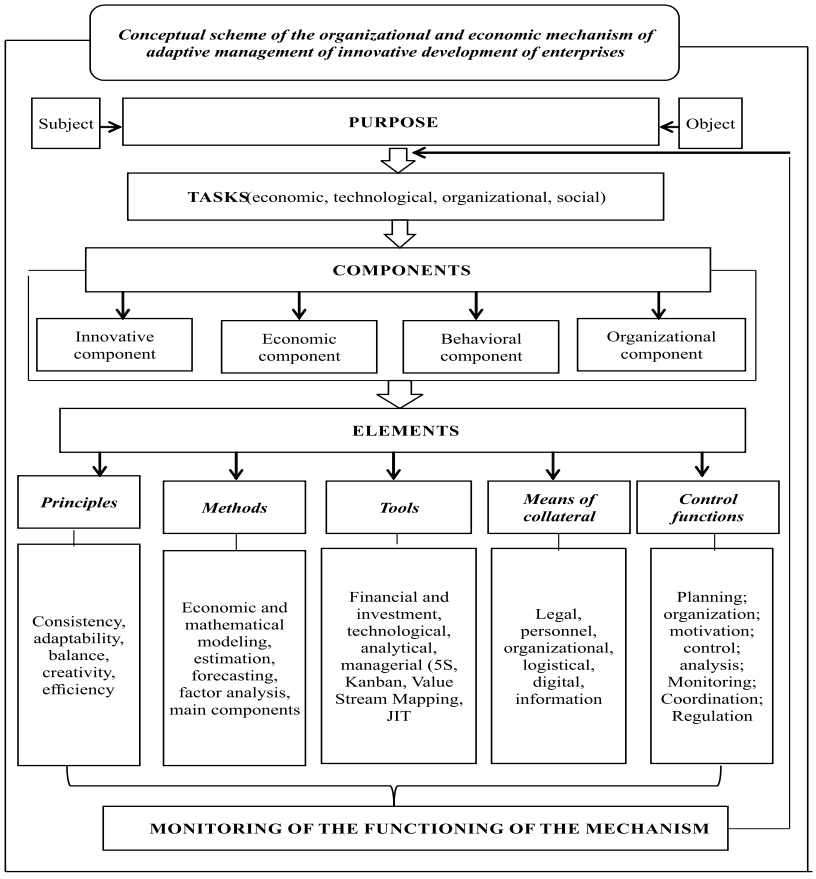
Source:Eurostat (2024).

Implementation of innovative developments also requires training of employees with appropriate qualifications and with certain skills and competencies, which require time for training and retraining of specialists. Flexibility and adaptability depends on how motivated employees are to adapt to new requirements in development of innovative and digital technologies. In the era of development and active implementation of innovative technologies in production, directions of digitalization of these processes are the use of large databases (Big Data), used to predict trends and make management decisions.

Adaptation of the lean approach to development and implementation of digital content consists in the maximum elimination of possible losses, using automated analytical systems to identify bottlenecks. Development of digital technologies allows optimizing supply chains through digital platforms, which is especially relevant for Ukrainian enterprises that are in the stage of their development and entry into international markets. Using integrated management systems will increase transparency level of business processes, which will increase consumer trust and improve competitiveness.

Adaptive management of innovative development in activities of enterprises involves constant updating of strategies and flexible response to environmental challenges using Agile project management methodologies for rapid adaptation to changes, using digital platforms for knowledge and innovation management, and culture formation of continuous improvement (Kaizen) within the Lean approach. For practical implementation of adaptive management measures, it is advisable to form the mechanism for innovative development of enterprises taking into account the Lean approach (Fig. 4).

Figure 4. Conceptual diagram of the organizational and economic mechanism of adaptive management of innovative development of enterprises



Source: developed by the authors.

Conceptual scheme of the organizational and economic mechanism of adaptive management of innovative development of enterprises includes the goal, subject, object, tasks, components, methods, tools, principles, means of support and management functions. The specified conceptual approach, unlike existing ones, includes the behavioral component that characterizes adaptability and flexibility of enterprise management in implementing innovative activities. These properties are implemented based on using management influence tools that are identified in the lean approach, which is aimed at economical use of resources and production optimization.

The important role in innovative development of enterprises is played by intellectual potential of the enterprise. Let us consider current trends in participation of employees of enterprises in implementation of innovative and scientific developments. Results of the analysis demonstrate significant decline in the indicated indicator, namely: 2010 - 182484 employees, 2015 - 122504 employees, 2020 - 78860 employees, 2023 - 58567 employees, which is more than 3 times less than in 2010 (Table 2).

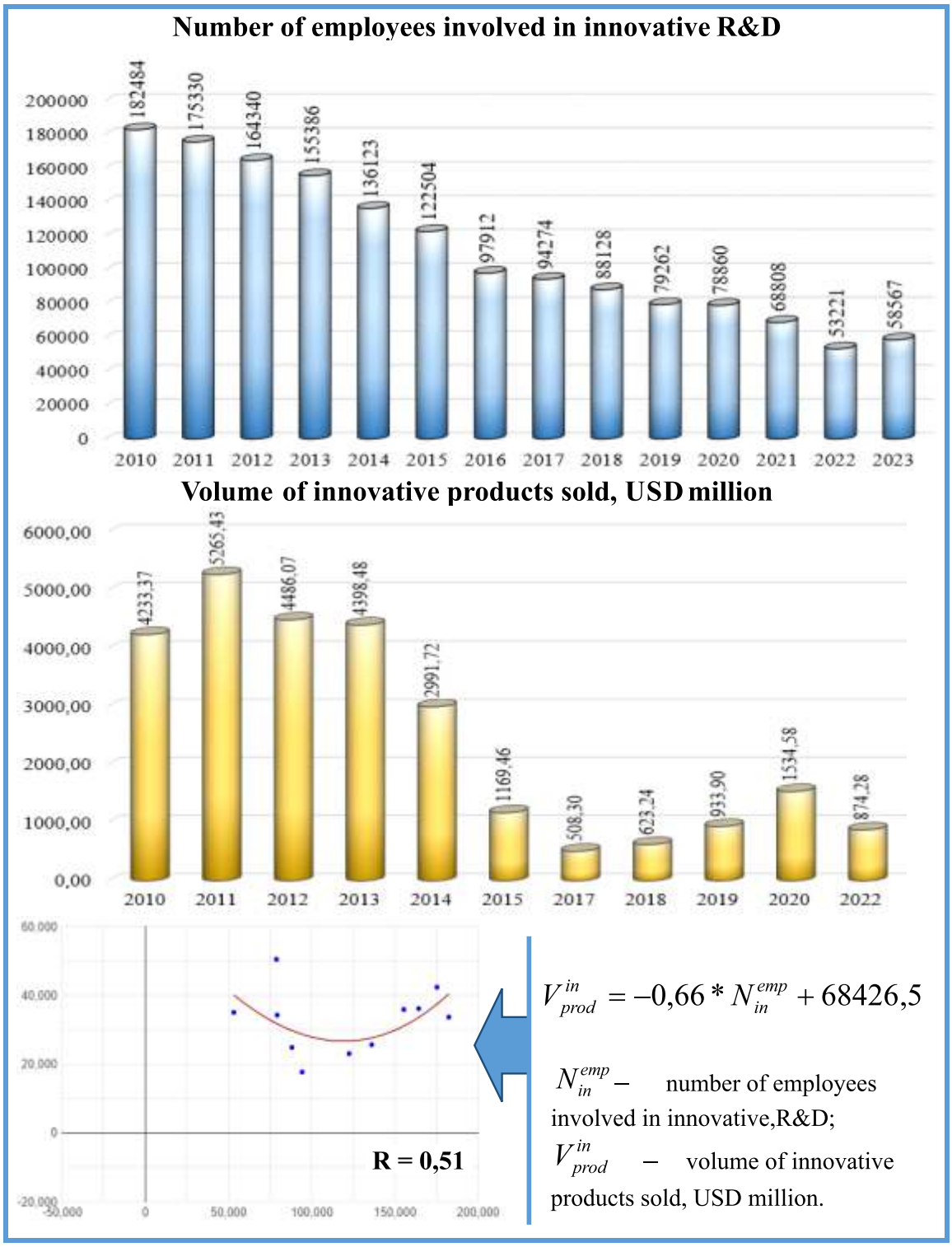
Table 2. Dynamics of the number of employees involved in innovative R&D, 2010-2023

	R&D personnel - total, persons	*Number of employees involved in innovative R&D, including*					
		researchers		*technicians*		*support staff*	
		Persons	*%*	*persons*	*%*	*persons*	*%*
2010	182484	133744	73,3	20113	11,0	28627	15,7
2011	175330	130403	74,4	17260	9,8	27667	15,8
2012	164340	122106	74,3	15509	9,4	26725	16,3
2013	155386	115806	74,5	14209	9,2	25371	16,3
2014	136123	101440	74,5	12299	9,0	22384	16,5
2015	122504	90249	73,7	11178	9,1	21077	17,2
2016	97912	63694	65,1	10000	10,2	24218	24,7
2017	94274	59392	63,0	9144	9,7	25738	27,3
2018	88128	57630	65,4	8553	9,7	21945	24,9
2019	79262	51121	64,5	7470	9,4	20671	26,1
2020	78860	51427	65,2	7117	9,0	20316	25,8
2021	68808	44615	64,8	5889	8,6	18304	26,6
2022	53221	36084	67,8	5020	9,4	12117	22,8
2023	58567	38845	66,3	4542	7,8	15180	25,9

Source:State Statistics Service of Ukraine (2024)

It is worth noting the significant impact of the number of employees engaged in research and development (R&D) on the volume of innovative products sold, which is due to the increase in innovative potential, acceleration of the innovative development process, improvement of product quality, rapid adaptation to market changes, etc. The results of economic and mathematical modeling prove the indicated impact (Fig. 5).

Figure 5. Results of the analysis of the impact of number of employees involved in innovative R&D on volume of innovative products sold



It is proposed to use classical management functions in formation of the conceptual scheme of the organizational and economic mechanism, since this approach is universal for most enterprises of different forms of ownership and types of economic activity, which makes it more universal. However, taking into account impact of the external environment, all specified components can be supplemented, expanded or changed depending on needs of management.

General principles of forming the concept for adaptive management of innovative development of enterprises are highlighted, since specific principles must be applied to specify the scope of activity or specifics of development of a particular enterprise.

Thus, general principles included the principle of systematicity, which involves considering processes and enterprises as a set of interrelated functions, which implementation leads to achievement of the set goal.

The principle of adaptability, which characterizes property of the object to respond in a timely manner to changes with the least expenditure of resources and time.

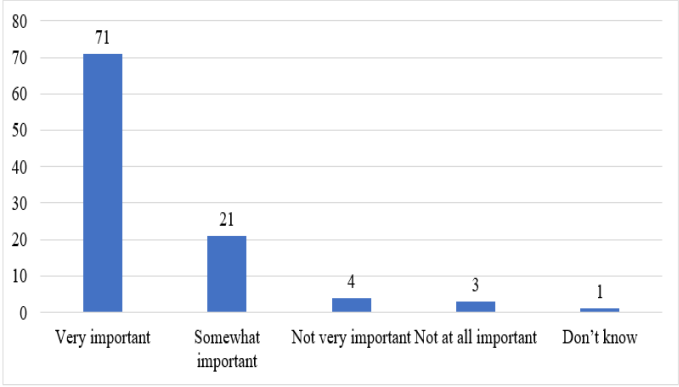
The principle of balance characterizes correspondence of costs and benefits to all participants in the process.

The principle of creativity characterizes available non-standard approaches to solving problems and tasks, creating the innovative product or service.

The principle of efficiency is one of the key ones in the management system, since it is it that determines expediency of introducing innovations, their ability to generate economic, social or technological benefits. In modern conditions of high competition and rapid change of the market environment, efficiency of innovation processes acquires special importance, because any investment in innovations must not only correspond to strategic goals of the enterprise, but also provide specific positive result in the short or long term.

Based on results of the study on the role of innovation in development of enterprises, we can note following results. 71% of respondents are confident in extremely important role of innovation in the company's success, 21% of respondents indicated that innovation plays significant role, while 4% said it does not play very significant role, 3% did not play a role at all, and 1% were undecided (Fig. 6).

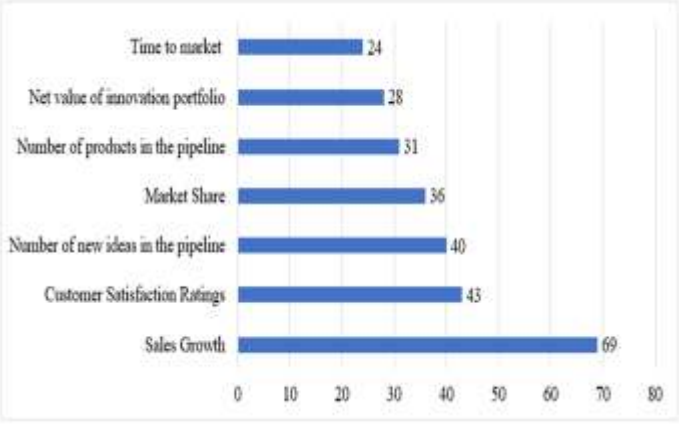
Fig. 6. Importance of innovation to the success of your company now, % of respondents



Source: Yaqub, M. (2024)

According to respondent companies, the following situation emerged regarding various indicators that are influenced by innovations: 69% noted sales growth, 43% focused on customer satisfaction, 40% noted significant importance of the number of new ideas in developing innovations, 36% noted growth of market share, 31% consider volume of products produced to be important indicator, 28% named the net value of the innovation portfolio as important indicator of innovation, and 24% noted importance of the time to market for an innovation (Fig. 7).

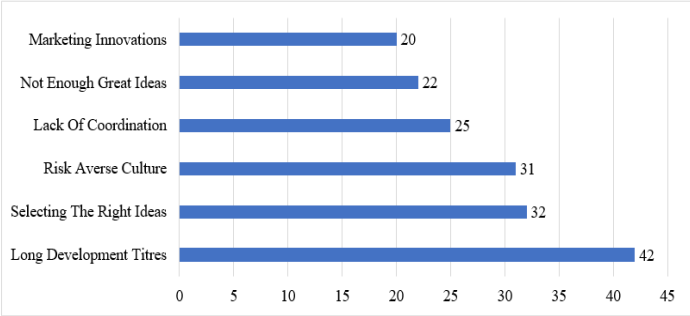
Fig. 7. Innovation's impact: sales growth is the top metric, % of respondents



Source: Yaqub, M. (2024)

Investigating factors that hinder development and implementation of innovations at enterprises, respondents noted the following: 42% long time to develop innovations; 32% difficulty choosing the right ideas, 31% risk aversion, 25% lack of coordination and direction of actions towards development of innovations, 22% insufficient number of innovative ideas, 20% problems with marketing innovations (Fig. 8).

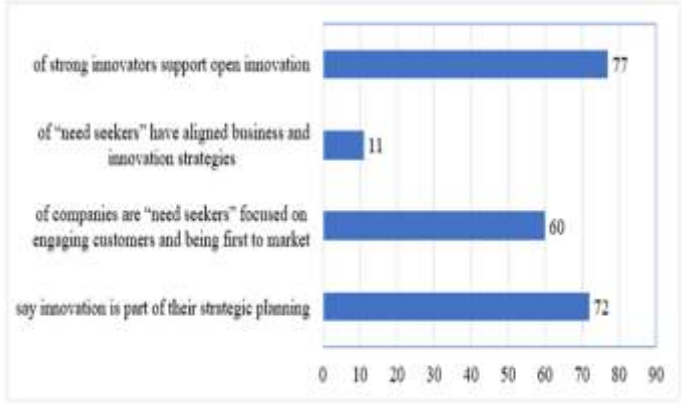
Fig. 8. Obstacles to innovation success,% of respondents



Source: Yaqub, M. (2024)

Among key success factors for implementing innovations, respondents noted: 72% noted that innovation is part of strategic planning, 60% are focused on attracting customers, 11% focus on aligning business strategy and innovation, and 77% focus their activities on open innovation (Fig. 9).

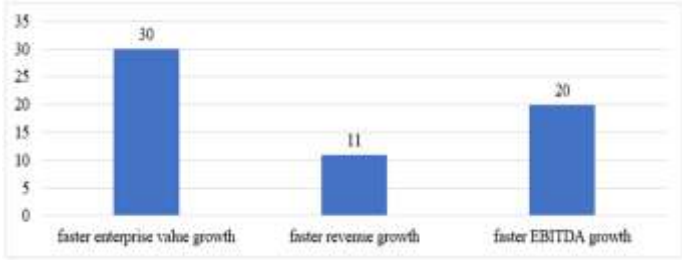
Fig. 9. Success factors,% of respondents



Source: Yaqub, M. (2024)

Results of the survey analysis show that innovative companies experience 30% faster growth in enterprise value; revenues of companies that actively implement innovations grow 11% faster, and innovative companies see EBITDA growth 20% faster (Fig. 10).

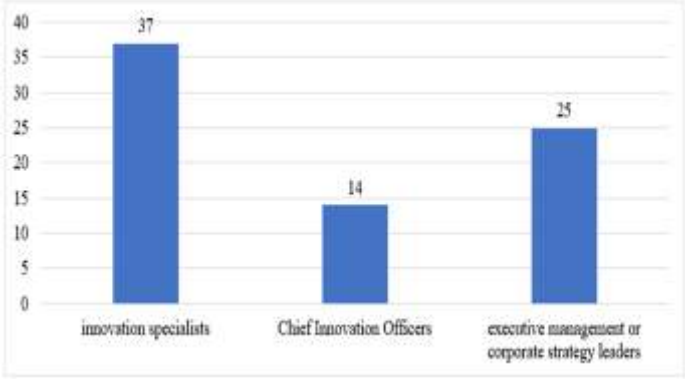
Fig. 10. Role of innovation in company growth, % of respondents



Source: Yaqub, M. (2024)

It was found that innovation specialists are responsible for 37% of innovation projects, 14% of innovation projects are under the leadership of Chief Innovation Officers, and 25% of innovation projects are under leadership of heads of structural divisions or top management of companies (Fig. 11).

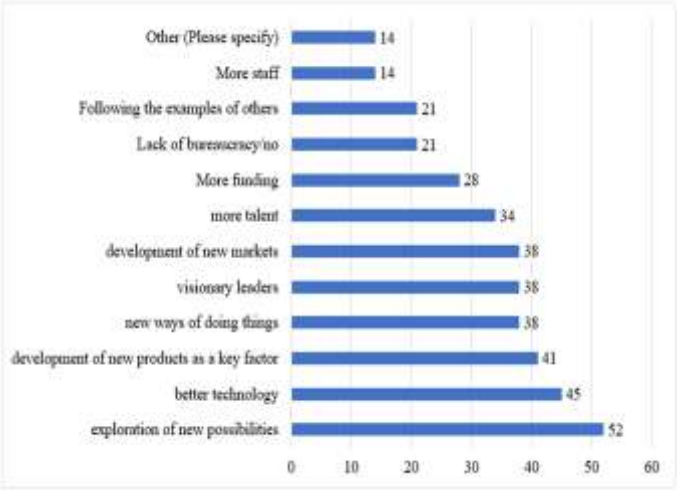
Fig. 11. Innovation project managers, % of respondents



Source: Yaqub, M. (2024)

Among main factors contributing to innovations development, it is worth noting: 67% of companies believe that search for new opportunities contributes to increasing innovative activity of the enterprise; 61% emphasize important role of technology, 59% consider development of innovative products to be important factor, 58% highlighted innovative ways of working, 45% focused on developing new markets, 42% highlighted important role of talent in implementing innovations (Fig. 12).

Fig. 12. Reasons for companies' increased innovation activity, % of respondents



Source: Yaqub, M. (2024)

In modern conditions of environmental uncertainty, it is advisable to use methods of organizational and economic mechanism that allow maximum consideration of impact of factors and strength of their interdependence, which allows predicting behavior of individual components when influencing the certain component.

The most common methods today are methods of economic and mathematical modeling, which, based on various software products, simulate economic processes of various levels, which allows you to study behavior of the subject for certain period of time, taking into account impact of external and internal factors.

Using evaluation methods today is complex analytical process that involves studying effectiveness and efficiency of the implementation of innovative projects, level of innovation potential, as well as impact of innovations on overall development of the enterprise. The choice of evaluation method depends on goals, type of innovation, industry specifics and phase of innovation cycle, and uses quantitative and qualitative methods, which, if necessary, should be combined. The most common evaluation methods include the method of expert assessments, SWOT analysis, benchmarking, risk assessment and others.

The method of factor analysis and the principal component method allow, in conditions of high variability and uncertainty, to determine most significant factors that affect the resulting characteristic (positively or negatively), which allows, based on management decisions in strategic perspective, to effectively manage economic and production processes for efficiency of the enterprise.

Means of ensuring implementation of the developed organizational and economic mechanism cover all areas of production and economic activity (legal, personnel, organizational, material and technical, digital, information). Legal means form possibilities of implementing certain projects, ensure rotection of intellectual property rights, consumers, commercial secrets, personal data, etc. They regulate implementation of innovative projects in legal field both within one state and in the international arena.

Staffing is implemented based on acquired competencies and qualifications of employees who can generate new ideas, projects, and creative approaches, which allows enterprises to use the latest solutions to maintain their competitiveness. Modernization of material and technical base for domestic enterprises is one of the priority tasks of their development, since most have significant equipment wear and tear due to lack of financial capacity, especially for enterprises that have been destroyed due to armed aggression by Russia. Digitalization has made significant breakthrough in management processes due to automation, which significantly simplifies implementation of most operations, speeds up the processes of making management decisions, and allows for more accurate accounting of a large amount of data.

The important process for studying effectiveness of the adaptive management mechanism is monitoring, which allows you to identify deviations from planned indicators over a certain period of time. To make management decisions about further actions, it is important to identify deviations, risks, and threats in timely manner to minimize or eliminate them.

The feature of the proposed conceptual scheme of adaptive management of innovative development of enterprises is that it is focused on using the Lean approach - an approach that involves economical use of resources through production optimization. Effective management requires

integration of all these elements into single system that will allow the enterprise to ensure high level of its competitiveness in the long term.

Conclusions

Thus, this study proposes the conceptual scheme of the organizational and economic mechanism of adaptive management in the context of digitalization, the main elements of which are the goal, objectives, principles, methods, tools and components of enterprise development. According to the proposed conceptual scheme, main components are innovative component, economic component, behavioral component and organizational component.

Using the proposed conceptual scheme will allow enterprises to quickly adapt to changes, flexibly and quickly respond to changes in consumer demands, which will provide the enterprise sustainable development in the long term. The proposed use of the Lean approach allows enterprises to optimize their production, which will allow them to increase efficiency of resource use, which will positively affect the company's profit.

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