

ECONOMIC SCIENCES

INNOVATIVE APPROACHES TO MANAGING TECHNOLOGY PARKS IN THE CONTEXT OF THE FORMATION OF THE KNOWLEDGE ECONOMY

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Abstract

In the context of the emerging knowledge economy, technology parks are becoming crucial elements of the innovation infrastructure, integrating science, education, and production. Their effectiveness largely depends on the application of modern management approaches based on digitalization, strategic planning, and analytical tools. The purpose of this article is to explore innovative approaches to technology park management and determine their role in developing innovation and enhancing the competitiveness of regional economies. The study examines modern management methods, including digital platforms, network interaction models, startup support mechanisms, and tools for assessing the performance of technology parks. Particular attention is paid to increasing managerial flexibility, coordinating innovation ecosystem participants, and streamlining decision-making processes. The study's results confirm that the introduction of innovative management tools contributes to increased efficiency of technology parks and accelerates the development of the knowledge economy.

Keyword: technology park, innovative management, knowledge economy, innovative infrastructure, innovative ecosystem, digitalization

The current stage of global economic development is characterized by a transition to a knowledge economy, in which the production, dissemination, and effective use of knowledge, innovation, and high technology are becoming key growth factors. Under these conditions, the role of innovation infrastructure, which facilitates the interaction of science, education, and business, is growing. One of the most effective elements of this infrastructure is technology parks, which help create a favorable environment for the development of innovative companies, the commercialization of scientific research, and the introduction of new technologies into production [1].

Technology parks serve as important intermediaries between research organizations and industrial enterprises, providing technology transfer, support for startups, and the formation of innovative clusters. Their activities contribute to the competitiveness of the national economy, the development of high-tech industries, and the attraction of investment. In a context of intensifying global competition and accelerating technological change, the effectiveness of technology parks is largely determined by the quality of management and the ability to adapt to new economic realities.

Currently, traditional approaches to technology park management require improvement, taking into account digitalization processes, the development of networked interactions, and the growing importance of intellectual capital. The use of innovative management tools, digital platforms, and the growing importance of intellectual capital. The use of innovative management tools, digital platforms, and analytical systems can improve the coordination of innovation ecosystem participants, optimize decision-making processes, and ensure

the sustainable development of technology parks. Consequently, the study of innovative approaches to technology park management in the context of the emerging knowledge economy is a pressing scientific challenge, with significant theoretical and practical implications for the development of an innovative economy and the efficiency of innovation infrastructure [2-3].

The purpose of this study is to analyze and substantiate innovative approaches to technology park management in the context of the emerging knowledge economy, as well as to determine their impact on improving the efficiency of technology parks and the development of innovation. The study aims to identify modern management tools and mechanisms that contribute to improved coordination of interactions between participants in the innovation ecosystem, optimized management decision-making processes, and increased competitiveness of technology parks. Particular attention is paid to the role of digital technologies, network management models, startup support mechanisms, and strategic planning tools in ensuring the sustainable development of technology parks. Furthermore, the study aims to identify the key factors influencing the effectiveness of technology park management and develop recommendations for the implementation of innovative management solutions in the context of the knowledge economy.

In modern scientific literature, technology parks are viewed as crucial elements of innovation infrastructure, facilitating interaction between science, business, and government, and facilitating the commercialization of scientific research and the development of high-tech industries. Research shows that technology parks create a favorable environment for innovation, stimulate the

creation of new businesses, and contribute to increased economic competitiveness [4].

Considerable attention has been paid in scientific studies to the role of technology parks in the formation of innovation ecosystems and the development of the knowledge economy. According to research by foreign and domestic scholars, technology parks facilitate effective interaction between universities, research centers, and industrial enterprises, facilitating technology transfer and accelerating the implementation of innovation in production [5]. Within the framework of the Triple Helix concept, technology parks are viewed as platforms that unite scientific organizations, businesses, and government agencies, thereby facilitating the development of innovation clusters and increasing the effectiveness of innovation [4].

A separate area of research is related to the assessment of the effectiveness of technology park management. Scientific papers propose various methodological approaches, including the use of a system of integrated indicators to assess the level of innovative activity, management effectiveness, and the performance of technology parks [6]. These studies emphasize the need to implement modern management tools aimed at increasing the efficiency of resource use and improving the coordination of participants in the innovation infrastructure. In addition, the scientific literature widely examines the international experience of technology parks, including the models of the USA, Germany, and China. Researches note that the successful development of technology parks is associated with the use of innovative management methods, support for startups, the development of digital infrastructure, and the formation of effective mechanisms for interaction between participants in the innovation process [7]. Despite a significant number of studies, many aspects of technology park management in the context of the formation of a knowledge economy remain insufficiently studied. In particular, the application of digital technologies in technology park management, the use of platform solutions, the development of network forms of interaction, and the improvement of strategic management mechanisms require further research. This determines the need for further scientific research aimed at developing innovative approaches to technology park management in the context of a knowledge economy.

In the context of the emerging knowledge economy, the importance of technology parks as key elements of innovation infrastructure, facilitating the integration of scientific research, technological development, and entrepreneurial activity, is growing. However, the effectiveness of technology parks is largely determined by the quality of the management system, which can ensure the coordination of interactions between various participants in the innovation ecosystem, including research organizations, educational institutions, innovative enterprises, and government agencies.

Currently, traditional technology park management methods, based primarily on administrative approaches and limited use of modern digital tools, do not fully meet the requirements of the knowledge economy. This is reflected in the ineffectiveness of management decision-making processes, weak integration of digital

technologies, low levels of commercialization of scientific research, and insufficient coordination between innovation participants. Furthermore, increasing global competition and accelerating technological change require the implementation of flexible, adaptive, and innovative management models. Existing scientific research primarily examines the general functioning of technology parks and their role in the innovation economy. However, insufficient attention has been paid to the development and implementation of innovative management approaches focused on the use of digital technologies, analytical systems, and network interaction models. Therefore, there is a need for scientific substantiation and the development of innovative approaches to technology park management aimed at improving their efficiency and ensuring sustainable development in the knowledge economy.

To achieve this goal, the article uses a set of general scientific and special research methods that allow for a comprehensive study of innovative approaches to the management of technology parks in the context of the formation of a knowledge economy.

The study utilized an analysis and synthesis method, which allowed for an examination of the theoretical foundations of technology park management, identification of key development trends, and a synthesis of existing scientific approaches to organizing innovation activities. A systems approach was employed to examine the technology park as a holistic socio-economic system, encompassing interconnected elements of innovation infrastructure, innovation process participants, and management mechanisms.

A comparative method was also employed to compare various technology park management models and identify the most effective management models and identify the most effective management practices. A structural-functional analysis was used to identify the key functions of technology park management and assess the impact of innovative tools on their operational efficiency. Furthermore, a logical generalization method was employed to formulate conclusions and justify the need to implement innovative approaches to technology park management. The use of this combination of methods ensured the scientific validity of the study results and allowed for the development of practical recommendations for improving technology park management systems in the knowledge economy.

In the emerging knowledge economy, technology parks are becoming key hubs for the generation, implementation, and dissemination of innovation. Their effective functioning depends on the adoption of modern management approaches focused on increasing management flexibility, strengthening interaction between innovation participants, and actively leveraging digital technologies. The study showed that traditional administrative models for managing technology parks do not provide the necessary level of adaptability and efficiency in a dynamically changing innovation environment.

One of the most important innovative approaches is the implementation of digital management platforms that automate management processes, monitor the activities of technology park residents, and increase the transparency of management decision-making. The use

of digital information systems allows for the collection, processing, and analysis of data on the activities of innovative companies, assessing their effectiveness, and promptly identifying problems. Research results have shown that the use of digital tools helps reduce the time required for management decision-making by 20-30% and improve the efficiency of resident coordination.

An important area improving technology park management is the use of network collaboration models based on partnerships between research organizations, universities, innovative enterprises, and government agencies. This management model facilitates more effective knowledge sharing, accelerates more effective knowledge sharing, accelerates the commercialization of innovations, and promotes the development of a sustainable innovation ecosystem. The study found that technology parks that actively utilize network collaboration models demonstrate higher rates of innovation activity and investment attractiveness.

Of particular importance is the implementation of strategic management based on long-term planning for technology park development, taking into account changes in the external environment. The use of strategic tools, including SWOT analysis, strategic planning, and a system of key performance indicators (KPIs), allows for the identification of priority areas for technology park development and improved management performance. The study's results confirm that the use of a

strategic approach contributes to more efficient resource allocation and increased sustainability of technology parks.

Furthermore, an important factor in improving management efficiency is the development of support mechanisms for innovative companies and startups. Technology parks that provide residents with consulting services, access to financial resources, educational programs, and infrastructure demonstrate higher levels of innovative activity. The study found that the presence of a comprehensive support system contributes to an increase in the number of successfully implemented innovative projects and a higher level of commercialization of scientific developments.

To ensure the logical integrity of the study and a clear presentation of the proposed innovative approaches to technology park management, the study presents a figure, table and calculation formula reflecting the structure, content and assessment of management effectiveness in the context of the knowledge economy.

The figure presents a structural model of an innovative approach to technology park management, including key interrelated elements: digital management platforms, network forms of interaction, strategic planning, and mechanisms for supporting innovative companies.

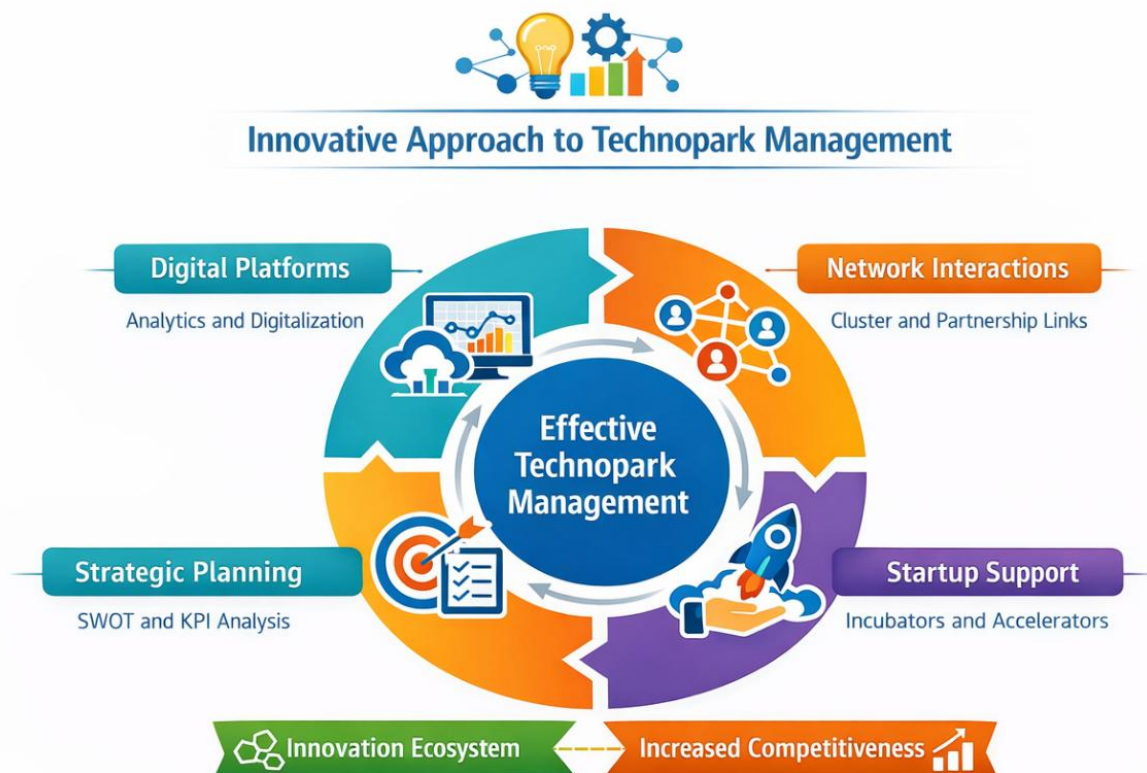


Fig. Innovative management structure for a technology park with digital tools

Central to this model is effective technology park management as an integrating element that ensures the coordination of innovation activities. The presented framework demonstrates that improved management efficiency is achieved through the integrated use of digital technologies, strategic tools, and the development of an innovation system.

Developing the model presented in the figure, the table systematizes the main innovative approaches to technology park management, their content, implementation tools, and expected results.

The table allows for the structuring of key areas for management improvement, including the digitalization of management processes, the development of net-

work interactions, the implementation of strategic management, and the use of analytical tools. The data presented confirms that the application of innovative man-

agement approaches contributes to the improved operational efficiency of technology parks, accelerated commercialization of innovations, and enhanced competitiveness.

Table

Innovative approaches to managing technology parks in the knowledge economy

№	Innovative approach	Contents of the approach	Implementations tools	Expected result
1	Digitalization of management	Using digital platforms to automate management processes analyze data	ERP systems, CRM systems, digital platforms, Big Data, decision support systems	Increased management efficiency, process transparency, and reduced management costs
2	Network interaction	Forming partnerships between universities, business and government	Cluster models, collaboration platforms, partnership agreements	Accelerating technology transfer and developing an innovative ecosystem
3	Strategic management	Long-term planning for the development of the technology park and identification of priority areas	SWOT analysis, KPIs, strategy maps, development roadmaps	Increasing the sustainability and competitiveness of the technology park
4	Startup support	Creating conditions for the development of innovative companies	Business incubators, accelerators, mentoring, financial support	Increasing the number of innovative enterprises and commercialization of developments
5	Analytical management	Using analytical tools to evaluate performance	BI systems, analytical dashboards, performance monitoring	Improving the quality of management decisions
6	Integration of innovative infrastructure	Consolidation of scientific, educational and industrial resources	Innovation centers, research laboratories, technology platforms	Strengthening innovative potential and increasing the effectiveness of interaction
7	Customer-oriented management	Focus on the needs of technology park residents	Feedback, digital services, personalized support programs	Increasing satisfaction and efficiency of residents and their activities

To quantitatively assess the effectiveness of technology park management in the context of the knowledge economy, an integrated formula is proposed that takes into account the level of digitalization, the development of network interaction, the effectiveness of strategic management, innovative activity, and analytical support for decision-making.

Formula for the integrated efficiency of technology park management:

$$E_{tp} = \frac{\omega_1 \cdot D + \omega_2 \cdot N + \omega_3 \cdot S + \omega_4 \cdot I + \omega_5 \cdot A}{T},$$

where: E_{tp} – integrated indicator of technology park management efficiency;

D – level of digitalization of management;

N – level of interaction and coordination through digital platforms;

S – project performance indicators;

I – project implementation time;

A – level of analytical support for decision making;

$\omega_1, \omega_2, \omega_3, \omega_4, \omega_5$ – weighting coefficients of the significance of the relevant factors, and

$$\omega_1 + \omega_2 + \omega_3 + \omega_4 + \omega_5 = 1.$$

This formula allows for a comprehensive assessment of technology park management effectiveness, taking into account key components of an innovative approach. The higher the E_{tp} value, the higher the level of technology park management effectiveness.

Using this formula allows for a comprehensive assessment of the effectiveness of technology park management and the impact of individual factors on its

overall development. The use of an integrated indicator allows for monitoring the effectiveness of management decisions and substantiating areas for further improvement of the management system.

The study's results also showed that the implementation of analytical tools and decision support systems contributes to improved management quality in technology parks. The use of modern data analysis methods allows for assessing resident performance, forecasting the development of innovative projects, and making informed management decisions. This, in turn, contributes to the increased competitiveness of technology parks and the development of an innovative economy. Thus, the study's results confirm that the implementation of innovative approaches to technology park management, including the digitalization of management processes, the use of network interaction models, strategic management, and the development of innovation support mechanisms, contributes to improved operational efficiency and ensures sustainable development in the context of the emerging knowledge economy.

In the context of the emerging knowledge economy, technology parks play a vital role in ensuring innovative development, serving as a link between science, business, and government. Their effectiveness is largely determined by the quality of their management system, which can ensure the coordination of innovation processes, support for startups, and the efficient use of intellectual and technological resources.

The study's results showed that traditional approaches to technology park management do not fully meet the modern requirements of an innovative economy, necessitating the implementation of innovative management solutions. It was found that the use of digital platforms and analytical systems contributes to the increased efficiency and validity of management decisions, improved monitoring of resident activities, and the optimization of management processes.

It has been proven that the use of network interaction models ensures more effective integration of innovation ecosystem participants, accelerates technology transfer, and increases the commercialization of scientific developments. The implementation of strategic management and a performance evaluation system help improve the sustainability of technology parks and ensure their long-term development.

Ultimately, the implementation of innovative approaches to technology park management is essential for improving their efficiency and competitiveness. Practical implementation of the proposed approaches will facilitate the development of innovative infrastructure and ensure the sustainable development of the knowledge economy.

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