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THE IMPACT OF DIGITAL TRANSFORMATION ON THE INNOVATIVE DEVELOPMENT OF ECONOMIC SYSTEMS

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Abstract
Taking into account the fact that in the current world, digital technologies are becoming drivers of innovations that affect the economic environment, contributing to the solution of complex problems and the emergence of new opportunities for differentiation, the impact of digital transformation on the innovative development of economic systems is a relevant research. The purpose of the article is to study the impact of digitalization on the innovative development of economic systems in modern conditions, which made it possible to identify the directions of efforts to ensure the innovative development of economic systems in the digitalization conditions. In order to identify the impact of digital transformation on the innovative development of economic systems, this study chose a methodological basis in the form of a systemic approach, which makes it possible to simultaneously take into account general scientific, general economic and applied aspects of the impact of digital transformation on the innovative development of economic systems. The most common problems of innovative development of economic systems are singled out and it is substantiated that it is possible to eliminate their negative impact on innovative development due to the processes of digital transformation. Digitalization tools and their impact on the economic systems' development are identified, including: cloud technologies, heterogeneous data analytics, artificial intelligence, digital platforms, robotics, virtual and augmented reality. The determinants of the innovative development of economic systems in the digitalization conditions are substantiated. The advantages of the impact of digitalization on the economic systems' development have been proven. The directions of efforts to ensure the innovative development of economic systems in the digitalization conditions are outlined. The innovative development of economic systems in the digitalization conditions in the form of closed functional dependence is presented.

Keywords: *digitization, digital transformation, intellectualization, territorial development, innovative development, economic system, business structures, regional space.*
JEL Codes: *O31, O33.*

Introduction

Digital technologies are becoming drivers of innovation that affect the economic environment, contributing to the solution of complex problems and the emergence of new opportunities. It is important to emphasize that innovation in the economy is no longer the exclusive prerogative of large corporations or developed countries. Digital technologies are democratizing opportunity, paving the way for startups, small and medium-sized enterprises, and countries that previously did not have a significant contribution to the global economy. In this context, innovative development takes on new dimensions, including not only technical

improvements, but also innovative business models, digital transformation strategies and resource management approaches. The dynamic development of Internet technologies, artificial intelligence, blockchain, the Internet of things and other innovative directions allows to create new markets, rewrite the rules of the game and ensure sustainable economic growth. In this context, it is important to consider innovative development as a key factor in the competitiveness of countries and enterprises. The ability to quickly adapt to changes, implement new ideas and technologies becomes strategically important for success in the constant digital evolution conditions.

The issues of innovative development of economic systems, digital transformation are reflected in the works of many scientists. However, questions regarding the features of the innovative development of economic systems in the digitalization context require further research, which are important for creating strategies that will contribute to sustainable economic development, increasing competitiveness, and improving the quality of life.

The purpose of the article is to study the impact of digitalization on the innovative development of economic systems in current conditions. To achieve the goal:

- the relevance and timeliness of the research are substantiated;
- an analysis of the relevance of this topic and its place in publishing activity was carried out;
- the most common problems of innovative development of economic systems are singled out and it is substantiated that it is possible to eliminate their negative impact on innovative development due to the processes of digital transformation;
- digitalization tools and their influence +on the economic systems' development are defined;
- the determinants of the innovative development of economic systems in the digitalization conditions are substantiated;
- the advantages of the influence of digitalization on the economic systems' development have been proven;
- areas of efforts to ensure innovative development of economic systems in digitalization conditions are highlighted;
- the presentation of the innovative development of economic systems in the digitalization conditions in the form of closed functional dependence is substantiated.

Literature review

Innovative development of economic systems is extremely relevant, especially in the conditions of rapid digitalization, which permeates all spheres of our life. This continuous process of transformation is marked by the introduction of the latest technologies, the acceleration of automation and the volume growth of information exchange. Many scientific articles are devoted to this direction of research, within which Samoilovych A. et al. (2021), Tulchynska S. et al. (2021), Popelo O. et al. (2021), Zhavoronok A. et al. (2022) studied the world experience and Ukrainian realities of digital transformation, regulatory policy, innovation and investment strategies for the development of economic systems. The concept of digitization of the economy is considered within the study Cheper A. et al. (2019), and the importance of the development of digital technologies on the basis of innovative development is also proven. The authors of article Lomachynska I. et al. (2023) analyzed the financial support for the innovative development of the economy in the digitalization conditions, identified problems and proposed ways of improvement. The purpose of the article Bochulia T. (2021) is to study the current problems of digital transformation of business as an innovative paradigm as a result of the multimedia society's development and the new economy. The research of He Mengfan et al. (2023) is aimed at analyzing the prospects of climate risk management in preparing a young digital workforce for decarbonization through the innovative development of a knowledge economy based on smart technologies. Within the scope of the study Berawi M.A. (2022), it is proven that innovative digital technologies, supported by a human-centered society, are a fundamental aspect in balancing economic development and environmental restoration.

Despite a significant number of studies, the issue of the impact of digital transformation on the innovative development of economic systems requires further research and analysis.

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Methodical approach

In order to identify the impact of digital transformation on the innovative development of economic systems, a methodological basis in the form of a systemic approach was chosen in this study. The systemic approach is an interdisciplinary approach and makes it possible to simultaneously take into account general scientific, general economic and applied aspects of the digital transformation impact on the innovative development of economic systems. The use of the methodology of the system approach to identify the impact of digital transformation on the innovative development of economic systems assumes that:

- the development of economic systems is a non-linear dynamic system;
- at the same time, it is taken into account that multi-level economic systems are both separate systems and subsystem components of higher-level systems;
- there are quantitative and qualitative direct and reverse relationships and dependencies between subsystems and systems of different levels;
- the systems' development takes place under the influence of general social, general economic and specific principles, laws, regularities;
- the effectiveness of the development of one subsystem or a certain component of the system gives a synergistic result for the higher-level system, which is greater than the simple sum of the development results.

The above determines that the methodology of the system approach is most optimally suitable for determining mutually determined phenomena and dependencies in the study of heterogeneous processes of social development of economic systems, including determining the impact of digital transformation on the innovative development of economic systems.

Results

In the era of rapid technological development and deep transformations in the digital sphere, innovative progress serves as an important driver of the economic systems' development around the world.

However, at the same time, some problems regarding the innovative development of economic systems are noted, on the example of Ukraine:

– an ineffective and weak mechanism for the introduction of innovations in the sphere of economic activity and their subsequent commercialization;

– insufficient state support for innovative projects and their insufficient financing both from the budget and at the expense of private investors;

– insufficient use of all opportunities related to scientific and technological cooperation, industrial policy and development of entrepreneurship;

– insufficient level of cooperation between research institutions and innovative enterprises.

This problem is the most common. All these aspects testify to the need to improve the mechanisms of implementation, support and cooperation in the area of innovative activity in order to maximize the scientific and innovative potential, which is important in the context of the economic systems' development, especially in the digitalization conditions, because digital transformation opens wide prospects for increasing productivity and efficiency in in various industries through the introduction of automated technologies. This process actively promotes the digital infrastructure development and high-speed Internet, which in turn become catalysts for the emergence of new digital services and business models. All these innovative solutions not only support economic development, but also make it more efficient.

The impact of digitalization on the economic systems' development is very diverse and comprehensive, it can be manifested due to the implementation and use of such tools of digital transformation as:

- cloud technologies, which allows subjects of economic systems to create, store and process large volumes of heterogeneous data, which ensures quick access to the necessary information and its use in activities and management decisions;

- analytics of heterogeneous data, artificial intelligence, which is carried out at the expense of modern information analytical tools and provides analysis of large volumes of data and selection of necessary information, determination of trends, construction of forecasts for decision-making and improvement of their efficiency;
- digital platforms that allow companies, customers and other stakeholders to be united for joint work and resource exchange, which helps to increase the efficiency of business processes and create new business models, which acts as an incentive for the small and medium-sized enterprises' development, startups and innovative projects;
- robotics, the introduction of robots and automated systems into production allows to significantly increase productivity and production quality, reduce production costs and ensure labor safety;
- virtual reality and augmented reality, the use of which makes it possible to increase the effectiveness of trainings, create new sales tools, etc.

Based on the above, the innovative development of economic systems in the digitalization conditions is determined by a number of key factors that influence the creation and successful implementation of innovative solutions (Fig. 1). The availability of high-quality and widely available digital infrastructure and qualified specialists in the field of digital technologies is the foundation for the implementation of innovative projects.

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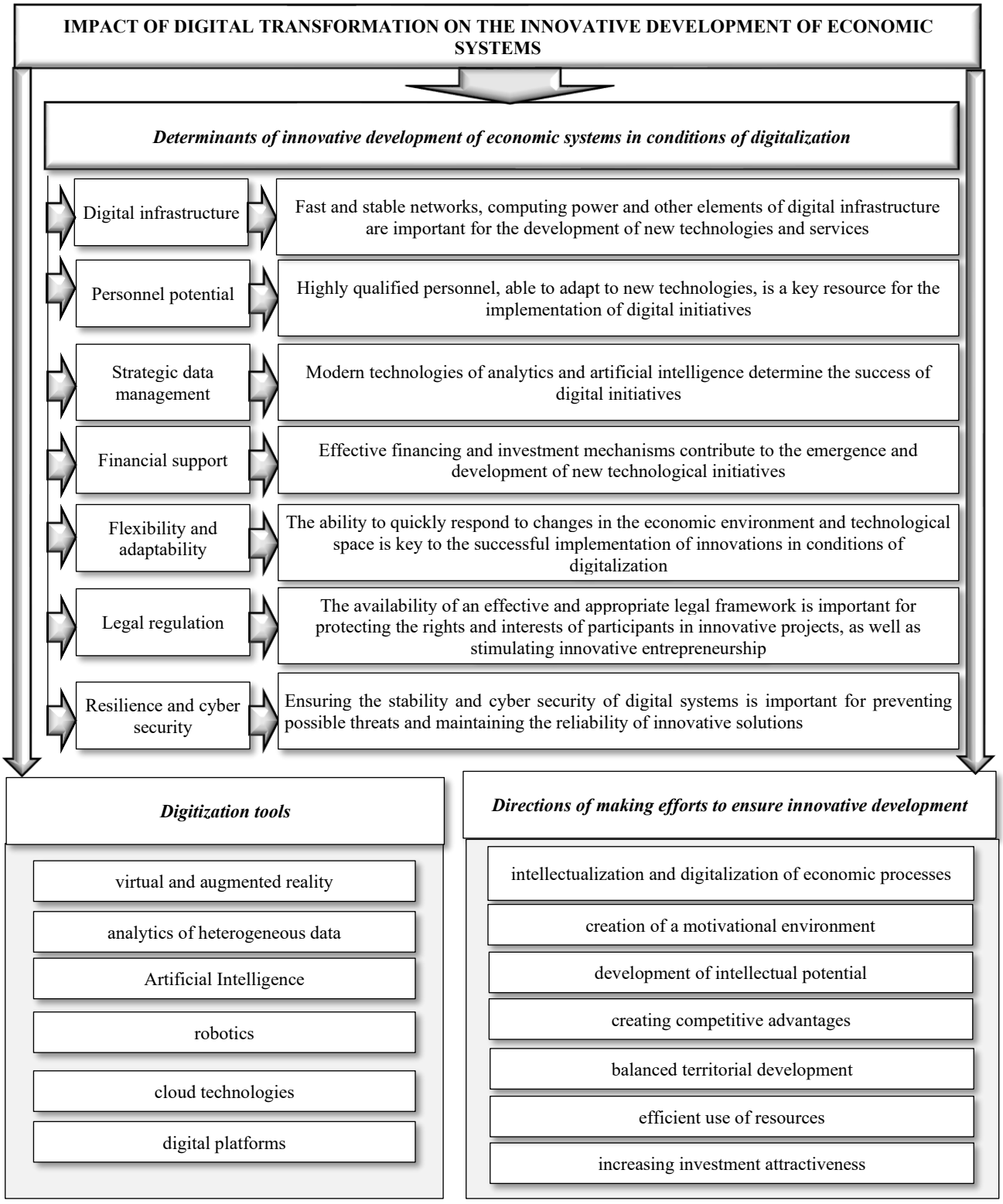

Figure 1. The impact of digital transformation on the innovative development of economic systems

**Source: constructed by the authors.*

In this context, in the digitalization conditions, the implementation of factors that determine the innovative development of economic systems should be aimed at several key areas:

- intellectualization and digitalization of economic processes – acceleration of intellectualization and digitalization processes in the regional space will contribute not only to increasing productivity, but also to creating a basis for innovative technological solutions and effective resource management;
- creation of a motivational environment and development of intellectual potential - formation of a favorable environment for the growth of the intellectual potential of the population and business structures, aimed at the use of digital tools, which promotes the development of innovations, social and corporate responsibility;
- creation of competitive advantages of an innovative nature - the development of innovative solutions should be aimed at creating competitive advantages for production, social and infrastructure structures with the help of digital initiatives;
- balance and consistency of territorial development - taking into account the unique features of the regional economic space in the context of intellectual and innovative development is important to ensure the balance and consistency of the development of individual territories;
- strategic orientation of sectors and effective use of resources - identification of strategically oriented sectors of the region's economy, taking into account the effectiveness of digitalization and innovation initiatives, will contribute to the effective use of resources and stimulation of innovation;
- increasing the level of investment attractiveness - increasing the level of investment attractiveness and strengthening the economic potential will be a key factor for providing resources for innovative and digital development, especially in the digital economy conditions.

In general, digitization has a positive effect on economic processes, because it opens up significant advantages for business entities, since:

- ensures high speed of transmission, exchange, storage and processing of information, thereby contributing to the improvement of communication processes;
- increases the efficiency of management through the integration of digital technologies in production and management processes;
- expands the capabilities of areas such as sales, marketing and communications, which contributes to business development;
- reduces capital investment in development, ensuring saving of resources;
- increases the level of satisfaction of consumers' needs through timely determination of their requests and response to them;
- ensures integration processes at different levels, promoting interaction between different segments of the economic space.

Based on the above, to the trends of digital transformation, in the context of the innovative development of economic systems that will gain importance in the future, it is important to identify several key directions. These include ensuring cyber security and digital data protection, training and attracting qualified professionals with relevant skills in digital transformation to effectively use their expertise at the regional level. Improving the exchange of experience and best practices between regions of the country in order to improve coordination in decision-making are also important elements. Developing partnerships with foreign participants to create new projects and improve existing digital solutions will also be a key factor. In addition, an important task is to improve the regulatory framework for digital transformation.

Therefore, digitalization in the context of the economic systems' development determines not only technological changes, but also new approaches to management, production and communication. In this regard, it is important to consider the potential of digital technologies to increase productivity and expand the capabilities of business processes. At the same time, successful innovative development requires solving challenges related to cyber security, provision of qualified personnel and efficient use of resources. Innovative development in the digitalization era becomes a strategic direction that determines the

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competitiveness of countries and forms a new landscape of economic development.

Therefore, the innovative development of economic systems in the digitalization conditions can be presented in the form of a certain closed functional dependence. So, let's present in the form of a relation (r) that the economic systems' development (DES) is dependent on innovative (I) development that is affected by digitalization (D). Then the functional dependence of the economic systems' development can be represented in the form:

$$r(DES), I \subseteq DES, D \subseteq DES \quad (1)$$

$$(I \to D) \Leftrightarrow \left((\forall t_1, t_2 \in r : t_1(I) = t_2)(I)\right) \Rightarrow (t_1(D) = t_2(D))) \quad (2)$$

where $(I \to D), \forall$ - determines that innovative development (I) acts as a determinant of the digitalization development (D) in the functional relationship (r) of the economic systems' development for all periods t_1 and t_2. That is:

$$(D \in I) \Rightarrow (I \to D). \quad (3)$$

Such functional dependence can be justified by the fact that digital transformation cannot occur without innovative development, in general, this is true. But digitalization, as proved in this study, has an unconditional impact on the innovative development of economic systems. Then this functional dependence should be presented in the following form:

$$(I \to D)\hat{}(D \to S) \Rightarrow (I \to S) \quad (4)$$

where S – is a set of factors that reflect the impact of digital transformation on the innovative development of economic systems, which can be presented in the form of a function, namely:

$$S(f) = \begin{cases} S_{DT} f(ct, hda, ai, dp, r, var), n = 6 \\ S_{DI} f(dd, hr, sm, fs, lr, sc), n = 6 \\ S_{EE} f(id, me, ip, ca, td, so, er, ia), n = 8 \end{cases} \quad (5)$$

where S_{DT} – digitalization tools: cloud technologies (*ct*), alytics of heterogeneous data (*hda*), artificial intelligence (*ai*), digital platforms (*dp*), robotics (*r*), virtual and augmented reality (*var*).

S_{DI} - determinants of innovative development of economic systems in the digitalization conditions: development of digital infrastructure (*dd*), increasing personnel potential (*hr*), strategic data management (*sm*), financial support (*fs*) and legal regulation of innovation processes (*lr*), sustainability and cyber security (*sc*);

S_{EE} – directions of efforts to ensure innovative development of economic systems in the digitalization conditions: intellectualization and digitalization of economic processes (*id*), creation of a motivational environment (*me*) and development of intellectual potential (*ip*), creation of innovative competitive advantages (*ca*), balance and consistency of territorial development (*td*), strategic orientation of sectors (*so*), efficient use of resources (*er*), increasing the level of investment attractiveness (*ia*).

Conclusions

The digitization conditions open up wide opportunities for the innovative development of economic systems, which are reflected in the ability to quickly and effectively implement and adapt innovative technologies in all spheres of activity.

The scientific novelty of the obtained results lies in the substantiation of directions for efforts to ensure the innovative development of economic systems in the digitalization conditions, which are based on the methodology of the system approach, are based on the definition of digitalization tools and their impact on the economic systems' development, substantiated determinants of the innovative development of economic systems in the digitalization conditions and highlighting the advantages of the impact of digitalization on the economic systems' development.

Digital technologies not only provide increased productivity, but also transform approaches to business processes, creating the foundations for sustainable and dynamic innovative development. Digitization in the context of the economic systems' development contributes to innovative progress, the development of the business environment and society as a whole. By ensuring the development of fast and efficient means of data processing,

digital transformation stimulates the emergence of new services and products that meet the needs of the discerning consumer. In addition, it opens up opportunities to improve the quality of life, influencing social and economic development. The irreversibility of digital transformation determines not only its positive impact, but also the need to solve numerous challenges. In particular, this concerns issues of cyber security, data privacy and socio-economic inequality. To achieve the maximum potential of digital transformation, society must implement strategies aimed at ensuring sustainability, ethics and equality in the digital space. In light of the rapid development of digital technologies and their impact on economic systems, the need for research in the field of innovative development is of particular importance. Advanced scientific research and analysis of digital trends will help identify optimal strategies for technology implementation, as well as solve related problems, ensuring sustainable and effective innovative development of economic systems in the digitalization context.

The issue of developing an organizational and economic mechanism for the activation of the implementation of the digitalization advantages to ensure the activation of the innovative development of economic systems at the level of enterprises, communities, regions and the national economy as a whole requires further scientific research.

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