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**DIGITAL MANAGEMENT IN THE INNOVATIVE DEVELOPMENT OF INDUSTRIAL ENTERPRISES**

*The article is devoted to issues of digital management in the conditions of industrial enterprises innovative development. The problems of management in the conditions of the “digital economy” are considered, as well as directions of development for their elimination. A new understanding of the “digital management” category essence is proposed. The advantages of effective use of digital management are determined. The role of managers in digital management structures is highlighted and the basis of requirements is outlined. A system of digital competencies was formed for the managers of the enterprise in the context of its innovative development. Emphasis is placed on the necessity and expediency of introducing managers’ accurate (calculation) work methods, formation and development of a social system (enterprise) functioning parametric model in an active environment for the creation of appropriate tools and methods. A structural model of an innovative enterprise digital transformation has been developed.*

**Keywords:** digital economy, digital transformation, digital management, digital technologies, business processes, structural model of enterprise digital transformation.

**Introduction.** The industrial landscape is formed under the influence of the fourth industrial revolution (Industry 4.0 and 4IR) [1], which, according to K. Schwab, will have four main effects on all industries. These are: changing consumer expectations; improving the quality of goods with the help of data, which increases the assets productivity; awareness by companies of new cooperation forms importance; integration of operational models into the new digital model [2]. In this context, the modern economy is going through a difficult period of structural and technological transformation due to the growing digitalization of economic activity. In such conditions, along with the already familiar mechanisms of activity and its management, there is a need to use new principles of activity organization. It is obvious that the classical approach to management is losing relevance and giving way to the principles of digital management.

Despite certain successes, Ukrainian enterprises have not fully converted their modern capabilities in the field of digital technologies into economic and social benefits (digital dividend). This requires a systematic approach that includes the implementation of approved measures, development of digital capacity and consistency with strategies for achieving the innovative development goals. Therefore, the introduction of digital technologies at enterprises requires the implementation of key digitalization initiatives to promote inclusive growth within the following tasks: digital development strategy development; creative and technological business entities modernization; strengthening of investment activity and economic breakthroughs; digital culture improvement; human resources development, their innovative and creative potential and competencies; increasing the human capital digital literacy; digital management communications management; transformation of internal market segments into highly efficient and competitive ones. The development of modern information technologies is the basis for the digital management implementation.

**Literature review.** The issue of digital management is widely considered in research and practical spheres. The feasibility of introducing digital management at enterprises is substantiated in the book [3]. In this context, the authors of the study [4] define digital management as managing a company using digital tools and specify this management as the last step in the process of digitization and robotization of companies' activities. In the article [5], the problem of digital management opportunities for business is raised based on modern key indicators. A number of domestic authors [6; 7] highlight the prospects of digital management as an integral component of the digital economy. At the same time, V. Melnyk [8] explores the conceptualization of digital management as the realization and expression of creativity in education and personality. Worthy of attention is the article [9], where the authors developed the concept of knowledge management of an industrial enterprise. The study [10] proposes steps to eliminate existing problems on the way to ensure high efficiency of digital management at enterprises.

However, the dynamism of the processes associated with the digital technologies spread and the digital management use requires further research into their impact on increasing the efficiency of all economic agents.

**The purpose of the article.** The purpose of the study is to justify the need and determine the prospects for the development of digital management in the innovative enterprise. The research hypothesis is that in today's conditions there is a conceptual transformation of the classic management paradigm.

**Results and discussion.** The digital management concept, as one of the key factors of ensuring the enterprises' efficiency in their innovative development context, is new for domestic business practice, therefore its features require a thorough study. The conducted research content in the context of digital management indicates a scientific interest in the issue of such a concepts conceptual determination as: "digitalization of economy", "digital enterprise", "digital transformation".

According to the estimates of a number of experts, "digitalization of the economy... takes place in the following strategic directions: digitalization of vertical and horizontal value chains – automation of production and supply management – "smart" production; digitization of goods and services – "smart" goods/services; digital business models ..." [11]. Digitalization provides high quality and convenience in many types of activities, such as online ordering of goods and services; remote work; distance education; electronic government; automated design; production; sales and artificial intelligence in the management of mechanisms, objects and systems.

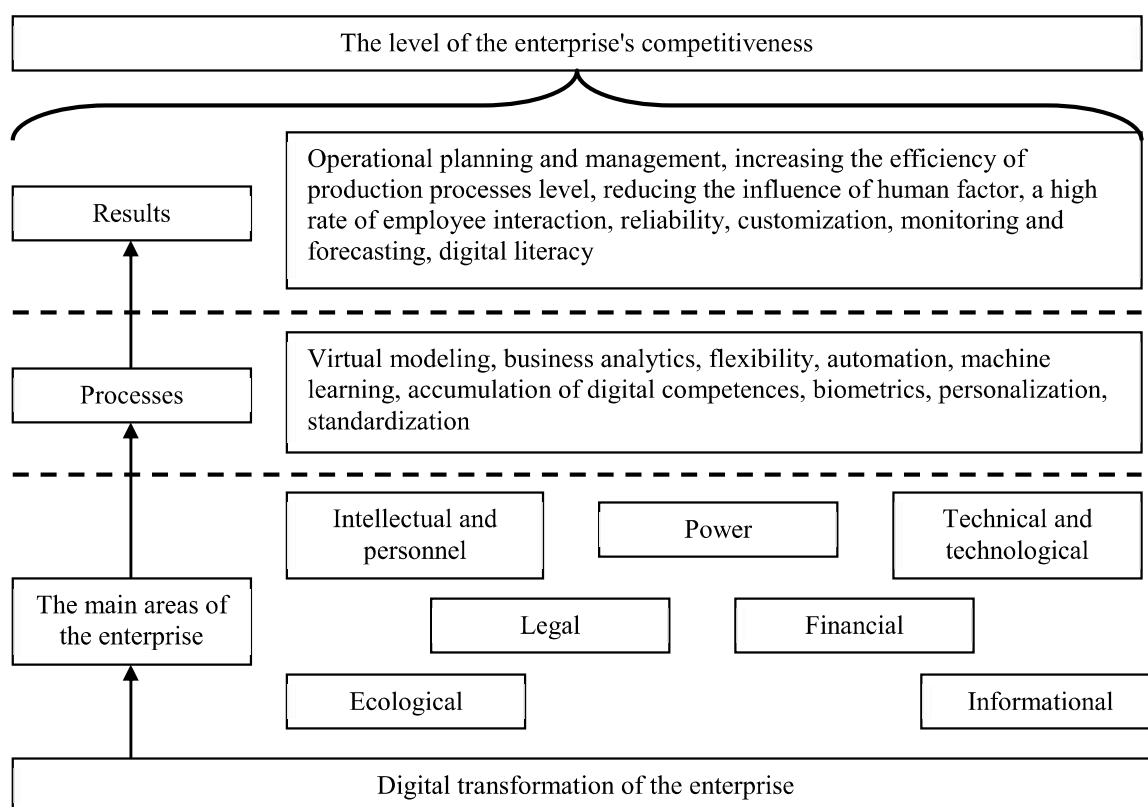
A digital enterprise is an enterprise that uses computer technologies in all areas of its activity: production, marketing, accounting, warehouse accounting, etc., which, accordingly, involves the automation of most processes, including organizational and managerial ones.

Digital transformation of the enterprise is a transition to activities that widely use digital information and communication technologies, including automatic collection of activity data, which increases transparency and controllability of activities. The logical consequence of this is an increase in the human capital digital maturity of business structures [12].

Digital transformation is preceded by processes of changing the industrial paradigm, namely, the main areas (components) that ensure the stable functioning of the enterprise in general (Fig. 1).

Digital changes in the financial component form a value vector of transformation. It is on the basis of the correct management of financial and investment flows that quality work is formed to determine the value of these resources, which will make it possible to reduce operating costs and identify new niches of income sources.

It is also worth paying attention to the technical and technological elements of the enterprise's structural model. Production processes radically change their form. Digital technologies bring the integration of various elements of work to a new level, allowing timely decisions to be made on the production lines reconfiguration and the new types of production introduction. Digital technologies collect information, control and measuring devices calibrate decisions in individual nodes of the production process and visualize the accepted concept of work if the risk of negative trends is high. Then, the enterprise's equipment is integrated into a common information platform, where artificial intelligence, using statistical competencies, comprehensively interprets the researched information and makes flexible and accurate management decisions regarding the operation of the company as a whole.



**Figure 1 – Structural model of innovative enterprise's digital transformation**

The intellectual and personnel sphere of enterprise functioning is also important in the context of the structural transformation model. This is due to the fact that the success of any economic entity depends on the human capital potential in the context of creating manufactured product added value. The degree of digital technologies use in the human resources management system determines the transformation from a traditional to a technological organization, which leads to an increase in the competitiveness of the enterprise. An actual task for enterprises is the deep network interactions formation between various structural units based on the process of platformization. Information flows become increasingly complex in nature as every digitized worker acquires digital value.

Power components play an important role in the functioning of the enterprise. Managers should not forget about the security measures of the organization as a physical object. It is necessary to use digital technologies from a security point of view, which can form a protective dome against both external and internal intrusion into the company. This facilitates biometric accounting of working hours and continuous monitoring of people's movements during the working day.

Digital transformation has led to a rethinking of the enterprises' functioning paradigm, making the information component one of the most urgent issues of secure development. Information flows lead to changes in markets and new attitudes towards customers and products. Platform-ability creates a trend to transfer the "locomotive" to digital rails thanks to artificial intelligence, which enables enterprises to provide a competitive advantage in this area. The digital model addresses some of the industry's most pressing environmental challenges. Digital platforms can provide a point and system analysis of current indicators trends, develop solutions to increase the efficiency of equipment, record the fact of incorrect operation when technological equipment deviates from the specified parameters, provide authentic full-fledged work processes to eliminate potential emergency situations. The use of digital solutions in the field of environmental protection directly affects the interests of various contractors and investors who want to improve the competitiveness of their companies.

Digital technologies are also undergoing changes in the legal field, as they require the development of basic legal solutions aimed at regulating quality in the context of their direct use in production. The development of standardization processes contributes to the transfer of knowledge and the further

development of digital solutions. Standards are one of the technological innovations effectiveness indicators.

By transforming separate elements, enterprises can ensure a higher level of competitiveness in the future. If management rests on this digital foundation and aspires to implement a full-fledged unified digital platform, it will achieve great success in the context of strategic development.

Let's highlight alternatives for making decisions based on the digital transformation of the enterprise.

1. Selection of production areas or specific activity types where modern technologies can be implemented. The direction analyzes the specifics of the enterprise and its potential for full or partial technological modernization. This variant of the innovations introduction is the main one and can be considered as a new structure and activity formation of the enterprise.

2. The second option – management makes a decision based on the chosen technology. A specific technology is chosen, and then a new activity forms developing process takes place. The enterprise is transformed under the technology, but not the technology under the enterprise.

The efficiency and effectiveness of the technologies use is not determined by their number. The successful implementation and adaptation of technology at the enterprise depends on how it is used in all its divisions, how much the innovation affects the results of the enterprise and how ready the employees are to implement the innovation.

Original management methods in the conditions of digital transformation are: creation of an innovation-oriented organizational structure and corporate culture, which guarantees the flexibility of the enterprise, adaptation to environmental changes, perception of innovations; building multidimensional trust relations with consumers; establishing direct contact with consumers; reduction of information asymmetry; formation of individually oriented value offers; transformation of the system leaders' role and requirements for their competence; creating an architecture based on the partners' interests, trust, accumulation of innovations and stimulation of creativity, but not on compliance with a set of norms.

Management of modern enterprises takes place in conditions of external environmental factors instability and temporal uncertainty, and one can agree with the opinion of some experts that such activities efficiency and the enterprise's competitiveness are largely achieved thanks to constant monitoring.

From the perspective of corporate dynamics, the enterprise is a strictly dynamic nondeterministic system operating in an active environment, which, by its very nature, is also a strictly dynamic nondeterministic system. In other words, these systems have at least one phase variable (system parameter) that has a non-zero rate of change at any instant of time. The nondeterminism of the system in general is defined by the fact that the system phase variables values change rate sign cannot be accurately predicted by the activity.

The enterprise management principles in the conditions of the digital economy development can be defined as follows: 1. the balance between digital and modern management technologies creates a single space for effective management; 2. traditional business models get improved or completely changed; 3. information space in management; 4. optimization of communication channels and balance between traditional and electronic business models; 5. activation of remote work models, such as outsourcing and outstaffing; 6. dynamic phases of the product and enterprise life cycle; 7. constant communication with clients through various channels and forms.

The use of the term "digital management" in modern scientific literature is still fragmentary. Sometimes digital management is used as a general term to denote information or, more precisely, computer management technologies that use large arrays of information for prompt and high-quality management decision-making. Digital management is based on the principles of technological development, scientific and technical methods of organizing business processes and so-called breakthrough technologies, which are formed on the basis of the knowledge society and smart society. The value of digital information management lies in its focus on digitization, which is determined by the efforts, competencies, qualifications and capabilities of specialists to solve complex computerization problems.



Therefore, digital management is a management process that uses information technology to collect and process large amounts of data in order to make optimal managerial decisions. In the modern world, computer technologies of data collection and processing not only ensure the availability and reliability of information, but also partially replace a person in the process of making manager decisions and their implementation. And in the future, computers will be able to replace managers in the daily management of many types of activities. It should be understood that in the concept of digital management, the main focus is on management. First, it is necessary to improve management systems, improve the quality of management potential, and then implement digital management methods. Under other conditions, it can lead to long-term managerial backwardness (wrong type of organizational structure, imperfect motivation systems).

Let's describe the approach to digital management (Table 1).

**Table 1 – A modern approach to digital management**

Criterion	Digital management
Management object	Combination of human and robotic work
Key resources	Digital resources
The role of managers	Role profile of communicators and coordinators
Communications	Digital collaboration
Management infrastructure	Digital offices, digital platforms
Organizational culture	Digital culture, virtual communication
Basis	Digital technologies
Use of "Industry 4.0" technologies	Extensive use
Competences	Digital competences (hard skills, soft skills)
A person who makes decisions	A person generates solutions using artificial intelligence
Strategic goal	Integrated goals of the organization, society, and individual

The difficulty of implementing the digital management concept is largely related to how well deterministic processes are automated (technical processes, material production processes, preferably without human intervention), but as soon as the process requires human intervention, the process ceases to be deterministic and unsuitable for automation by modern means. Traditional approaches (ERR, CRM, BPM, etc.) do not provide adequate automation of enterprise management processes and allow only fragmented solutions implementation. BigData also does not solve many management tasks and often creates the illusion of awareness.

Let's determine how to ensure the necessary digitization of management. In our opinion, the basis of digitization is the management activities computability. Management should be calculated. This applies to all management activities, but mainly to decision-making processes.

Computability in relation to business and management means the following: knowledge and use of a set of necessary and sufficient parameters that uniquely determine the state of the object; formative assessment of individual and team activity; calculation of managerial influences, including calculation of control documents.

Computability does not create itself. In order to improve management systems, extensive theoretical, methodological and organizational preparatory work is required. All this requires new competencies from managers, in particular:

- modeling of corporate systems, use of models for decision-making, obtaining information about the object (enterprise, division, individuals as functional units, market);
- determination of the target state of the enterprise in a parametric form;
- determination of the situation and development enterprise's trajectory;
- calculation of strategies and action plans (activity calculations);
- calculation of managerial influence (including documentation and advertising materials);
- assessment of the activity effectiveness by individual activities types; team's effectiveness evaluation based on the total activity of the participants;
- evaluation of the company functional (systemic) stability coefficient.

This is certainly not an exhaustive list of the managers' competencies in the era of the digital economy. However, even this list shows that the process of training management personnel needs significant restructuring. In this context, scientific and educational organizations play an important role. Firstly, the conceptual and categorical apparatus of management needs rethinking, revision and addition. Therefore, a new terminology is needed in the context of solving management tasks. With regard to computerized automation, theoretical material should be prescriptive, not descriptive, and avoid ambiguity. Secondly, it is necessary to continue work on the formation and refinement of parametric models that adequately reflect the enterprises' functional processes in the conditions of an active external environment, in particular, the inflow of resources, including cash.

One of the problems with modern theories used to train managers is that they ignore activity as an economic category. In addition, many parameters that determine the state of the social system (enterprise) and the environment in which it functions are not taken into account. The models used by economists do not take into account the availability of information (for example advertising) and are often based on assumptions that are convenient for proving theorems. Therefore, solutions cannot be calculated.

Parametric models of social systems functioning in an active environment provide for the system and environment phase variables (parameters) fixation, which allows to clearly determine the state and, accordingly, monitor the dynamics of the system [13]. At the same time, computer technology and electronic devices that exist in today's conditions have high capabilities in the context of providing data collection and processing for the assessment of system changes in real time. As a result, it has become possible to create software that enables managers to calculate managerial implications, system dynamics, information for planning and, thus, to solve a range of business tasks.

**Conclusions.** Digital transformation of domestic enterprises is a process that is ambiguous in terms of effectiveness and difficult to manage. Digital transformation should have a continuous nature, due to the speed of changes in digital technologies, and should be carried out taking into account a thorough analysis of the enterprise's external and internal environment. Without taking into account the current digital trends that are actively spreading among enterprises, the choice of technologies is impossible. At the same time, it is necessary to forecast which of the digital products will have a long-term effect and will be useful for the enterprise, considering the peculiarities of the internal environment and the management system, and which are only short-term trends. Platformization processes form the development of the business model of a specific business entity. The management of the enterprise must understand the problem of rapid changes in digital processes regarding the maintenance of objects and subjects in the digital system for the need to ensure continuous work on the correlation of separate business models elements, as well as, if necessary, to fully reconstruct the ecosystem in general. On this basis, it is possible to ensure a stable and progressive evolution in cases of new digital counterparties or technological innovations entry, which will make it possible to ensure a higher level of enterprise's competitiveness.

Digital technologies are able to change the level of enterprises' competitiveness, labor productivity, and the business process management efficiency. However, like any tool, they do not guarantee high results without the right strategy of innovative development and balanced management decisions. In this context, the classical approach to management loses relevance and gives way to the principles of digital management. Under these conditions, enterprises that have implemented digital management are more dynamic. In addition, such enterprises are well prepared for changes and self-learning. Digital management changes business processes, enterprises and the role of managers. Thus, managers are required to be able to work with digital technologies, analyze large volumes of data, implement innovations and develop strategies in a dynamic environment. With the use of digital management, it is possible to comprehensively track business and increase the efficiency of management decisions; brand recognition, as the geography of the company's presence expands; improving interaction with customers; growth of economic efficiency in comparison with the traditional form of management; displaying key performance indicators and, as a result, providing additional competitive advantages of the enterprise.

Human capital is a key element for successful digital management, as the knowledge, skills, experience and mental abilities of employees influence the digital development of an enterprise or an entire country. The Industry 4.0 development strategy will probably soon pass to an improved version of this strategy – Industry 5.0, which will strengthen the human-centric approach in all areas of life, since not all processes can be robotized, and it is people who will play a key role in the transition from a digital to a virtual economy.

The conclusions and recommendations of the study serve as the basis for further scientific, theoretical and applied developments in the context of building an organizational and economic mechanism for ensuring the effective use of domestic industrial enterprise's intellectual potential in the knowledge-based economy formation.

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### **ЦИФРОВЕ УПРАВЛІННЯ В УМОВАХ ІННОВАЦІЙНОГО РОЗВИТКУ ПРОМИСЛОВИХ ПІДПРИЄМСТВ**

**Проблема.** Цифрова трансформація вітчизняних підприємств – процес неоднозначний за результативністю та непростий в управлінні. Цифрові технології здатні змінювати рівень конкурентоспроможності підприємств, продуктивності праці, ефективності управління бізнес-процесами. Однак, як і будь-який інструмент, вони не гарантують високих результатів без правильної стратегії інноваційного розвитку та виважених управлінських рішень. У цьому контексті класичний підхід до управління втрачає актуальність і поступається місцем принципам цифрового управління.

**Мета.** Метою дослідження є обґрунтування необхідності та визначення перспектив розвитку цифрового управління в умовах інноваційного підприємства. Гіпотеза дослідження полягає у тому, що в умовах сьогодення відбувається концептуальна трансформація класичної парадигми управління.

**Результати.** Стаття присвячена питанням цифрового управління в умовах інноваційного розвитку підприємств. Розглядаються проблеми менеджменту в умовах «цифрової економіки», напрями розвитку для їх усунення. Запропоноване нове розуміння сутності категорії «цифрове управління». Визначена роль менеджерів у структурі цифрового управління та викладено основні вимоги. Наголошується на необхідності та доцільності введення точних (розрахункових) методів роботи менеджерів, створення та розвитку параметричної моделі соціальної системи, що функціонує в активному середовищі для створення відповідних інструментів та методик.

**Наукова новизна.** Сформована система цифрових компетенцій у менеджерів підприємства в контексті його інноваційного розвитку. Розроблена структурна модель цифрової трансформації інноваційного підприємства. Розвинуто методичне підґрунтя цифрового управління підприємств на основі людино-центристського підходу.

**Висновки.** Цифрова трансформація вітчизняних підприємств є процесом неоднозначним за результативністю та непростим в управлінні. Цифрова трансформація повинна мати неперервний характер, зумовлений швидкістю зміни цифрових технологій, і здійснюватися з урахуванням ретельного аналізу зовнішнього та внутрішнього середовища підприємства. Без урахування актуальних цифрових трендів, які активно поширюються серед підприємств, вибір технологій неможливий. При цьому слід прогнозувати, які з цифрових продуктів матимуть довгостроковий ефект і виявляться корисними для підприємства з урахуванням особливостей внутрішнього середовища та системи менеджменту, а які є лише короткостроковими трендами. На рівні окремих підприємств і менеджменту діяльності виявлено переваги цифровізації: усунення посередників (продаж товарів/послуг за допомогою інтернет-ресурсів); оптимізація витрат на пошук інформації, ідентифікацію і вимір транзакційних витрат, витрат на просування товарів і послуг, витрат на заключення і ведення переговорів тощо; прискорення всіх бізнес-процесів; зменшення терміну виготовлення продукції, підвищення її якості та функціонування підприємства загалом.

Процеси платформізації формують розвиток бізнес-моделі конкретного суб'єкта господарювання. Керівництво підприємства має розуміти проблему швидкої зміни цифрових процесів щодо утримання об'єктів та суб'єктів у цифровій системі для необхідності забезпечення безперервної роботи з корелювання окремих елементів бізнес-моделей, а також у разі потреби повномасштабно реконструювати екосистему загалом. На цій основі можна забезпечувати стабільну та прогресивну еволюцію у випадках входження нових цифрових контрагентів або технологічних нововведень, що дасть змогу забезпечити більш високий рівень конкурентоспроможності підприємства.

Цифрові технології здатні змінювати рівень конкурентоспроможності підприємств, продуктивності праці, ефективності управління бізнес-процесами. Однак, як і будь-який інструмент, вони не гарантують високих результатів без правильної стратегії інноваційного розвитку та виважених управлінських рішень. У цьому контексті класичний підхід до управління втрачає актуальність і поступається місцем принципам цифрового управління. За цих умов підприємства, які впровадили цифрове управління, є більш динамічними. Крім того, такі підприємства добре підготовлені до змін і самонавчання. Цифрове управління змінює бізнес-процеси, підприємства та роль менеджерів. У цьому контексті від менеджерів вимагається вміння працювати з цифровими технологіями, аналізувати великі обсяги даних, впроваджувати інновації та розробляти стратегії в умовах динамічного середовища. За використання цифрового менеджменту є можливим комплексне відстеження бізнесу та підвищення ефективності управлінських рішень; впізнаваність бренду, оскільки розширюється географія присутності підприємства; покращення взаємодії з клієнтами; зростання економічної ефективності в порівнянні з традиційною формою управління; відображення ключових індикаторів ефективності та, як наслідок, забезпечення додаткових конкурентних переваг підприємства.

Людський капітал є ключовим елементом для успішного цифрового управління, оскільки знання, навички, досвід і розумові здібності працівників впливають на цифровий розвиток підприємства або цілої країни. Стратегія розвитку Індустрії 4.0, ймовірно, найближчим часом перейде до вдосконаленої версії цієї стратегії – Індустрії 5.0, що посилить людиноцентричний підхід у всіх сферах життя, оскільки не всі процеси можна роботизувати, і саме люди відіграватимуть ключову роль у переході від цифрової до віртуальної економіки.

Висновки та рекомендації дослідження служать основою для подальших науково-теоретичних і прикладних розробок в контексті побудови організаційно-економічного механізму забезпечення ефективного використання інтелектуального потенціалу вітчизняних промислових підприємств в умовах становлення економіки, заснованої на знаннях.

**Ключові слова:** цифрова економіка, цифрова трансформація, цифрове управління, цифрові технології, бізнес-процеси, структурна модель цифрової трансформації підприємства.

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