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The digital twin as a virtual copy of real production is the basis for improving the efficiency of innovation activity of industrial systems

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Abstract: the effectiveness of innovation activity is largely determined by the state of organizational and managerial structures of the enterprise, which should be focused on making effective decisions in the context of the introduction of digital technologies. The article considers the possibilities of using digital twin technology to manage the innovation activities of industrial enterprises. It is proved that the digital twin technology makes it possible to obtain information about the properties of a future innovative product faster, reduces the volume of field tests due to virtual tests, as well as through the use of accumulated and analytically processed historical data on the design and operation of similar products.

Keywords: innovation, innovation management, industrial systems, digital twin, industry 4.0, digital economy.

The economy of Kazakhstan in modern conditions needs accelerated development of the innovation sector, characterized by a high share of intellectual capital, the peculiarity of the stages of creating innovative products, from the emergence of a scientific idea to its implementation and embodiment in material form — a product in demand by the market, the production and sale of which should compensate for significant and long-term time investment costs.

Innovative transformation of economic processes in industry is a key priority of the current stage of socio-economic development of Kazakhstan. Innovative activity promotes scientific and technological progress not only at the level of economic entities, but also at the territorial level, while creating prerequisites for sustainable economic growth and improving the quality of life of the population.

Modern industrial enterprises are interested in the production and implementation of innovations in various forms, since innovations, regardless of the type, allow them to increase their competitiveness by reducing production costs or ensuring a monopoly position on the market. In turn, the effectiveness of innovation activity is largely determined by the state of the organizational and managerial structures of the enterprise, which should be focused on making effective decisions in the context of the introduction of digital technologies.

Currently, Kazakhstan's industry is forced to respond to global changes, which are based on digitalization — the process of transition to new management models, the introduction of special business models and management tools related to the use of information technology. Solving the problems of digitalization of the domestic industry is one of the factors of its adaptation and adaptation to the changed institutional environment. These circumstances actualize the need to develop new approaches to managing the development of industrial economic systems, taking into account the peculiarities of the digital economy and the requirements of innovative digital transformations.

The most important catalyst for the new stage of digital transformation is the growing success in the development of advanced technological areas, including artificial intelligence, robotics, blockchain, virtual and augmented reality technologies, and others. These technologies provide industrial systems with unique capabilities, including high accuracy of forecasting and making management decisions based on data, multiple cost reductions, and ensuring the best quality of the "consumer experience".

Industry 4.0 is a new concept of production systems that covers technologies such as the Internet of Things, big data, cyber—physical systems and intelligent objects. Industry 4.0 will present new challenges and opportunities for researchers and managers in the field of process safety and environmental protection.

Analyzing the digital economy as a phenomenon and process, it is necessary to take into account the variability of its definitions and the close relationship with the innovation-type economy.

Products and services are the result of enterprises' activities in the context of the digital transformation of the economy. At the same time, a distinctive feature of the digital economy is that these results often turn out to be virtual, services are acquired remotely, which allows enterprises to receive economic and financial benefits with costs significantly lower than in the production of goods and services in traditional spheres of public production.

Virtuality and remoteness are the main advantages of the functioning of business entities in the digital economy, thanks to them, conditions are created for a significant increase in the efficiency of innovative production in literally all industries [1].

Transformations in industry occur according to the concept of "Industry 4.0." characterized by the emergence of cyber-productions, cyber-systems and cyber-machines. Digitalization and the possibility of outsourcing the development of new products and business services, manufacturing and rapid prototyping have allowed small companies and project teams to create innovative products and quickly bring them to market on a par with the large companies present there.

The most important element of the digital transformation of industry at the stage of product development is the introduction of computer and supercomputer modeling technologies and "smart" digital models (digital twins) created taking into account the target characteristics of products, on the one hand, and resource constraints, on the other, with subsequent virtual testing, optimization and even virtual certification.

One of the key technologies that increase the efficiency of the innovative activity of industrial systems is the digital twin. In fact, it is now recognized as a key part of Industry 4.0. This category continues the CALS and PLM methodologies that appeared at the beginning of the XXI century. The annual growth of this market from 2020 to 2026 will be about 58% [2]. The use of digital twin technology of innovative production processes allows to reduce the number of failures, it is possible to predict the response of equipment to operational loads with 95% accuracy, and reduce the operating costs of complex industrial complexes by 5-10%.

The digital double is of particular interest as a technology that is at the intersection of digital and physical reality and at the same time develops against the background of convergence of a number of new promising technologies, such as additive technologies, artificial intelligence, the Internet of Things, etc.

Digital twins can change the role of traditional production processes by changing the ways innovative products are produced. The digital twin technology allows for the transition to intelligent manufacturing technologies, the formation of big data processing systems, and contributes to solving a number of complex technical problems in industry.

Many large industrial enterprises face the problem of declining competitiveness — despite the abundance of implemented information systems, the planning of production projects remains at a low level. The digital twin is the central focus of solving the problems described above. Its implementation reduces the development time of prototypes, accelerates the process of bringing them into compliance with the technical specification, reduces the cost of operation and increases the speed of bringing an innovative product to market. This digital technology allows you to

quickly create and test various modifications of the product and radically reduces the number of field tests, which leads to a significant reduction in the cost of innovation.

In non-digital production, when using approximate calculations, the designer needs to give an increased margin of safety, not knowing exactly what maximum operating loads arise in the product with complex loading schemes. This approach leads to the fact that the material consumption of products is overstated, the cost of such a design is increasing, and the competitiveness of the entire product is falling.

The approach associated with the use of a digital double allows you to set an optimal safety margin, tested on a very large number of virtual tests and sufficient to ensure mechanical strength, but not leading to excessive strength, excess weight and increased manufacturing costs [3].

The digital twin makes it possible to obtain information about the properties of the future innovative product and design faster, reduces the volume of field tests by conducting virtual ones, as well as by using accumulated and analytically processed historical data on the design and operation of similar products.

As a rapid prototyping tool, the digital twin accelerates innovation and reduces costs. Industrial enterprises can test, correct and improve the details of a product even before its actual production.

Digital twins create virtual copies of real productions, control physical processes and make decentralized decisions. Such systems can be self-trained, self-adjusted, combined into one network.

For innovative industrial economic systems, an important issue is the use of digital twin technology in such a way as to ensure openness to stakeholders and preserve the welfare of personnel [4].

The creation of digital milking machines ensures the prompt production and supply of products with competitive properties in the conditions of global high-tech competition. The digital twin in certain industries allows modeling various kinds of changes and effects [5].

Using to varying degrees certain basic technologies of digitalization of production, enterprises build their digital counterparts in the form of global platforms for modeling, simulation and analysis of their innovative production systems.

To increase the efficiency of innovative activity of industrial systems based on the development of digital technologies, it is necessary to stimulate the full deployment of "local" digitalization with the introduction and practical optimization of digital technologies in all basic production processes of each individual enterprise; ensuring flexible monitoring of problems and successes of digitalization and active dialogue with production; as well as the development of a strategy for the introduction of digital technologies, hiring and training specialized personnel, cooperation with digital companies and research centers.

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