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PROSPECTS FOR DIGITALIZATION AND ROBOTIZATION OF THE ECONOMY OF KAZAKHSTAN

Abstract

A key factor in the development of Kazakhstan's economy is the digital transformation of manufacturing enterprises, the use of digital information and communication technologies to restructure the business so that all decisions are taken on the basis of data. The structure of digital transformation is presented. End-to-end digital technologies are used to collect, store, process, search, and transmit data electronically. The proliferation of IoT technologies and the use of data from IoT devices to improve automated solutions and optimize industrial production plays an important role in the transition to digital production. The most important task of modern business models is to create an omnichannel space, synchronizing data and information in all digital and physical interaction channels to meet the needs of customers at any time and in any place. The prospects for the development of digitalization and robotization of our economy are related to the development and implementation of robotic means. An important area of development of digitalization and robotization of the economy of our republic is the development and application of software robot managers. The structure of the software robot manager is given. It is noted that digitalization and robotization technologies will provide unique opportunities for Kazakh enterprises, including high accuracy of forecasting and making management decisions based on data, multiple cost reductions, providing a better quality "customer experience".

Key words: digitalization, robotization, digital transformation, economy, business processes, end-to-end technologies, robot manager

Introduction

Digitalization is the introduction of modern digital technology into various spheres of life and production.

The widespread implementation of digitalization in all spheres of modern life is becoming an objective reality. The application of digitalization at the enterprise changes both the external environment

of the organization in terms of conditions of interaction with the state, suppliers and customers, and the internal processes taking place in the company, in particular, in the area of management.

The challenges of managing an organization in the context of digitalization of production processes can include the following:

♦ changing business processes in the company on the basis of advanced digital technologies;

♦ maintaining a high level of knowledge of company management and specialists in the field of modern technology;

♦ maintaining a high degree of readiness to changes and challenges of the external environment.

The intensive development and proliferation of digital technologies in recent years have significantly changed the face of key sectors of the economy and the social sphere. More and more organizations are seeking to move their business processes to the digital environment, thereby significantly reducing transaction costs and significantly increasing the volume of economic activity. A giant, virtually barrier-free market is forming on the Internet with truly global competition and very high dynamics of all its elements (companies, products and services, consumers). Under such conditions, the need to account for and process large amounts of data becomes an important factor of competitive advantage. The sustainability and prospects of business development are determined by the ability to respond to changing customer needs many times faster than even 20–30 years ago, and to quickly bring new products and services to market through electronic sales channels.

The next wave of transformation of business and social models is taking place, driven by the emergence of the new generation of digital technologies, which are called "end-to-end. These include artificial intelligence, the Internet of Things, big data, blockchain, wireless communications, and others. [1]. Their implementation, according to experts, is capable of increasing labor productivity in companies by 40%. The tasks of managing an organization in the context of digitalization should include the following: – changing the company's business processes based on advanced digital technologies; – maintaining a high level of knowledge of company management and specialists in the field of modern technology; – maintaining a high degree of readiness to changes and challenges of the external environment. In entire countries and companies undergoing digital transformation of the economy, it is the end-to-end digital technologies that will determine the competitiveness of manufacturing companies in the future.

Materials and methods

Digitalization is the use of digital computer technology to redesign a business so that all business decisions are based on data. You can't digitalize just one part of a company. Digitalization cuts across the entire company, thereby achieving synergy between each area on a single digital platform and digital transformation of the enterprise.

From our point of view, the key feature of digital transformation that distinguishes it from similar concepts is qualitative changes in business processes and activity models, primarily arising from digital platforms, and the significant socio-economic effects of their implementation. Digital transformation is not only the introduction of digitalte chnologies, but also the transformation of multiple horizontal and vertical business processes, optimization of operational procedures, changes in established models and formats of interaction between value chain participants. New technological solutions require complementary investments in the improvement of organizational practices, development of employee competencies and a culture of working with data and digital solutions.

The digital transformation of manufacturing enterprises is an important trend in the development of Kazakhstan's economy. Digital transformation is the use of digital information and communication technologies to restructure the business so that all decisions are made based on the data obtained. Information and communication technologies as a class includes a huge number of tools and developments: from various state sensors to theories justifying the areas of optimal application of a particular architecture of software.

The purpose of this study is to consider promising areas of digitalization and robotization of the economy of Kazakhstan, a description of end-to-end technologies that ensure the digital transformation of business processes at manufacturing enterprises, development and application of a software robot-manager. In today's environment, organizations should look at their own business in the context of the

digital economy. Like it or not, the costs of research, development, consulting services, and employee training will inevitably rise as part of the digitalization of the company. Companies that are not prepared for such developments will sooner or later leave the market. On the other hand, digitalization should not be an end in itself. It is necessary to calculate the efficiency of these or those changes in order to be sure that the key processes at the enterprise will significantly improve as a result of digital technology implementation.

Main provisions

Digital transformation contributes to solving systemic problems in industries, reorganization of labor, and automation of routine tasks. For example, in the electric power industry, the number of accidents at infrastructure facilities is reduced, in construction – the level of injuries at construction sites is reduced. Thanks to digital products improve coordination within and between organizations and reduce transaction costs. For example, platform-based solutions in logistics reduce the role of intermediaries, while at the same time increasing opportunities for communication with end users.

The robotization of production processes plays an important role in increasing the efficiency of production plants, enhancing their competitiveness and profitability. Robotization also includes the development and implementation of software robots designed to automate and optimize managerial functions in manufacturing enterprises.

Scientific novelty of this article is determined by the methodology of using end-to-end digital technologies, research and development of software robots designed to automate and optimize management functions in manufacturing enterprises.

The relevance of the article lies in the digitalization and robotization of the economy in order to improve the efficiency of manufacturing enterprises, increasing their competitiveness and profitability through the introduction of digital technologies, methods and means of artificial intelligence.

To date, in Kazakhstan, work related to the automation and optimization of management functions has not been carried out. Even abroad, projects for digitalization and robotization of SMEs have not been carried out. In world practice, there is positive experience in the application of digital technologies and robots in production. Nevertheless, robots created abroad have not been applied to the management of production enterprises.

Literature review

The prerequisites for writing this article are the results of research published in [1, 3, 4, and 6]. The monograph "Digitalization and Robotization of the Economy" examines the essence of digital transformation, its importance and role in modern economic development. Digital technologies and the conditions of their use in manufacturing enterprises of small and medium-sized businesses are considered in detail. The work "Fundamentals of Robotics" describes intelligent robotic systems used in production process control systems in various sectors of the economy.

At present, almost all countries are in the process of digitalization of the economy. Each country has its own priorities for digital development. Today, more than 15 countries are implementing government digitalization programs. The leading countries in this process are New Zealand, China, South Korea Singapore, and Denmark. For example, China is combining digital technologies with traditional ones in its Internet Plus program, Canada is using an ICT hub in Toronto, Singapore is developing a smart economy based on ICT, South Korea is developing a government program "Creative Economy", based on the development of human capital and information dissemination. digitalization of the public sector is the main focus of digitalization of the economy in Denmark. The most advanced country in the development of the digital economy is Singapore. In 2014, the government initiated the development of the Smart Nation concept and engaged local businesses and the expert community to refine and implement the concept, aimed at improving the quality of life by introducing digital technologies into the daily lives of citizens. The state formulated initial tasks that were identified as paramount for the implementation of the Smart Nation concept [2].

Results and discussion

As noted above, digital transformation is the introduction of modern technology into the business processes of an enterprise. This approach implies not only the installation of modern hardware or software, but also fundamental changes in approaches to management, corporate culture, and external communications. As a result, the productivity of each employee and the level of customer satisfaction increase, and the company acquires a reputation as progressive and modern.
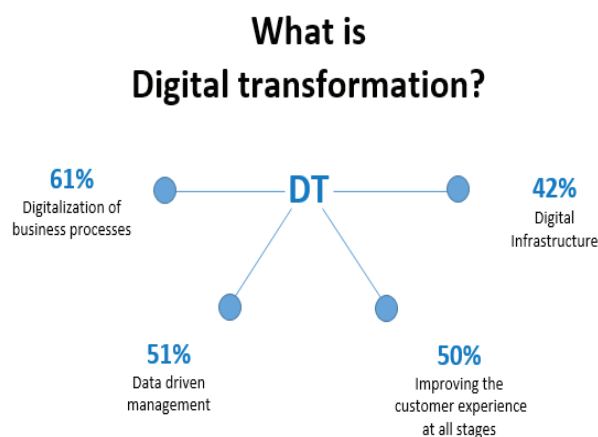
Figure 1 shows the structure of digital transformation.

What is Digital transformation?

61%
Digitalization of business processes

DT

42%
Digital Infrastructure

51%
Data driven management

50%
Improving the customer experience at all stages

Figure 1 – Structure of digital transformation

Note: Compiled by the authors.

This structure includes the following elements:
- Digitalization of business processes: doing more and faster with the same resources.
- Data-driven management: know the exact numbers and quickly remove the unprofitable.
- Improving the customer experience at all stages: correcting people's mistakes and making adjustments.
- Digital infrastructure: use modern digital technologies and tools.

The application of elements of digital transformation in the production enterprises of the republic will ensure an increase in labor productivity and improve the economic performance of these enterprises. Technologies accelerating the digital transformation of enterprises include Internet of Things, artificial intelligence, e-commerce, big data, cloud technology, blockchain, etc. They help expand markets and export potential, often turning businesses into microtransnational companies. Today, more and more enterprises are digitizing their operations, thereby transforming their value chains and becoming more productive, competitive, and profitable [3, 4].

Digital transformation involves the widespread use of end-to-end digital technologies. All sectors of the economy today need to use end-to-end digital technologies that collect, store, process, search, transmit data in electronic form, and which function on the basis of software and hardware. These technologies help change business processes and create new markets.

Digitalization of industrial production involves the integration of a number of breakthrough technologies: virtual modeling, Internet of Things, robotics, artificial intelligence, big data, cloud and edge predictive analytics, new communication standards, etc. Digitalization is carried out both within manufacturing process management (MOS/MES) and product lifecycle management (PLM) systems, and further production maintenance [5].

A significant role in the transition to digital production is played by the spread of IoT technologies and the use of data obtained from IoT5 devices to make (improve) automated decisions and optimize industrial production. The economic effect of the introduction of industrial IoT technologies by 2025 may be about 1.2–3.7 trillion $ [6].

The digitalization of the management of economic systems is carried out in the following areas that are directly related to ensuring the quality of human life:
- Public administration and regulation.

  ◆ Information infrastructure.
  ◆ Information Security.
  ◆ Smart city.
  ◆ Digital education.
  ◆ Digital healthcare.

Digitalization of public administration includes digital workflow, digital principles, and provides for the revision of inefficient processes. In this context, self-digitization covers the entire range of public administration services: internal interaction of government agencies – G2G, interaction with citizens – G2C, interaction with businesses – G2B.

Predictive maintenance and repair of equipment helps avoid accidents and leaks that negatively affect the environment.

For example, Shell has launched an AI and IoT-based platform things, which provides predictive maintenance and tune-ups for thousands of pieces of equipment and can predict leaks before they occurrence [7]. Digital twin technology, which combines the industrial Internet of Things and digital modeling, is being actively implemented in developed countries at all stages of the product lifecycle, from development to operation.

In 2021, about half of the world's major industrial companies will use this technology [8]. The introduction of "digital twins" for modeling and evaluating various scenarios will reduce the number of equipment failures by an average of 30% [9].

Digital services and the modern approach to the development of "smart" spaces significantly improve the conditions of human life.

Examples of this kind include smart cities, smart homes, digital workplaces, and factories. Today, the world is entering a period of accelerated provision of robust smart spaces, where technology is becoming an integral part of daily life for people in any his or her role-worker, customer, community member, citizen.

New product time-to-market (timeto-market) is an important parameter for the competitiveness of new business models. Designing and manufacturing products through the use of advanced manufacturing technologies ensures that time-to-market is reduced and modern approaches to product updates and improvements are used, adapting to changing customer needs by easily changing suppliers and testing new concepts and products. For example, Tesla launches new products and resolves customer complaints in real time; Facebook tests and launches its product updates to select user groups twice a day, etc.) [10].

To create an omni-channel space, synchronizing data and information in all digital and physical interaction channels to meet the needs of customers at any time and in any place is the most important task of modern business models.

Prospects for the development of digitalization and robotization of the economy of our republic are associated with the development and implementation of robotics [11].

The widespread application of robotics in industry will greatly complicate and diversify the production sector [12]. From individual manipulators to automated production lines, robotic complexes are involved in a wide range of tasks, from manufacturing of isolated elements to assembly and even transportation of finished products [13, 14]. Figures 2 and 3 show robotics used in industrial plants.

Figure 2 – Robotic car assembly area

Note: Compiled by the authors based on the source [14].

Figure 3 – 3D house construction with robots.

Note: Compiled by the authors based on the source [16].

In agriculture, robots will perform many operations, from caring for plants and animals (a striking example is hydroponic farms) to relieving humans of hard labor (unmanned planters and cultivators, combines, etc.) [15].

The use of robotics in agriculture has the following advantages:

♦ robots are capable of performing various operations – tillage, fertilizing, sowing, planting, milking cattle, shearing wool, feeding, cutting meat and fish, etc.;

♦ improving business efficiency through planning, making a field passport;

♦ increasing crop yields by monitoring the weediness of fields, sowing and prompt response;

♦ elimination of unauthorized downtime of machinery, control of field works;

♦ higher accuracy and speed of technological operations;

♦ functioning in aggressive, hazardous and dangerous places, inaccessible to humans;

♦ robots monitor the cultivation of plants, track the movement of pests, allow making electronic maps for agriculture.

Today, Kazakhstan produces self-controlled machines for spraying in the fields, orchards, various seeders and cultivators, combines for berry picking and other RTS (see Figures 4 and 5 (p. 124).

Figure 4 – Robot sprayer

Note: Compiled by the authors based on the source [16].

The use of unmanned aerial vehicles (drones) in agriculture can become the main tool of precision farming. The desire to implement precision farming technologies in modern agricultural enterprises leads to an increase in the efficiency of all processes. Using spectral sensors on drones, farmers can get information not only in the visual spectrum, but also in different spectral ranges to calculate vegetation indices or soil distribution maps. All data are provided with precise coordinates with the possibility of detailed study and laboratory analysis [16].

Figure 5 – Robotic cultivator

Note: Compiled by the authors based on the source [15].

One of the promising areas of development of digitalization and robotization of the economy of our republic is the development and application of software robots-managers.

When creating robot managers, methods and models of automated control, methods and tools of artificial intelligence, methods of fuzzy logic and neural network technology, as well as methods and models of optimization of production process management are used. The structure of the software robot manager includes the following basic blocks (Figure 6, p. 125 p.) [17]:

 ◆ block for input of incoming information from structural subdivisions of the enterprise, organization;
 ◆ analytical block, providing static and dynamic analysis of data coming from the input block of incoming information from the structural subdivisions of the enterprise, from sensor equipment, video cameras and other devices for collecting data on the activities of the enterprise;
 ◆ block of optimization tasks solution of management on the basis of the theory of optimal control, methods and models of artificial intelligence, fuzzy logic and neural networks;
 ◆ block of development of options for management decisions and the choice of the optimal solution;
 ◆ information and reference block, providing the head of the enterprise or organization with the necessary information on the state of production and economic activity.

The input unit receives data that includes complete information on the production activities of all structural divisions of the enterprise or organization. These data are structured in a certain way, submitted to the analytical block and the information and reference block. In the analytical block receives data, which include regulatory and legal materials, information about the status of the enterprise, the implementation of the products, fulfillment of contractual obligations, etc. The information input unit also receives data that includes information on production relations with external organizations, international relations and cooperation, etc.

In the block of optimization problem solving, based on the use of AI methods, neural networks, models and algorithms of optimal control will solve the problem of optimal control of various production processes performed by the given enterprise. In the block of optimal solutions selection, the optimal control solution for a particular task is selected, and the results obtained in this block are transferred for use to the head of the enterprise or company.

It should be noted that software robot managers used to manage firms, organizations and companies should ensure their adaptation to the digital transformation characterized by the use of broadband Internet, cloud services, RFID technologies, ERP systems, inclusion of firms and companies in e-commerce, as well as optimal regulation of financial, industrial, foreign economic, legal and social insurance activities of the company.
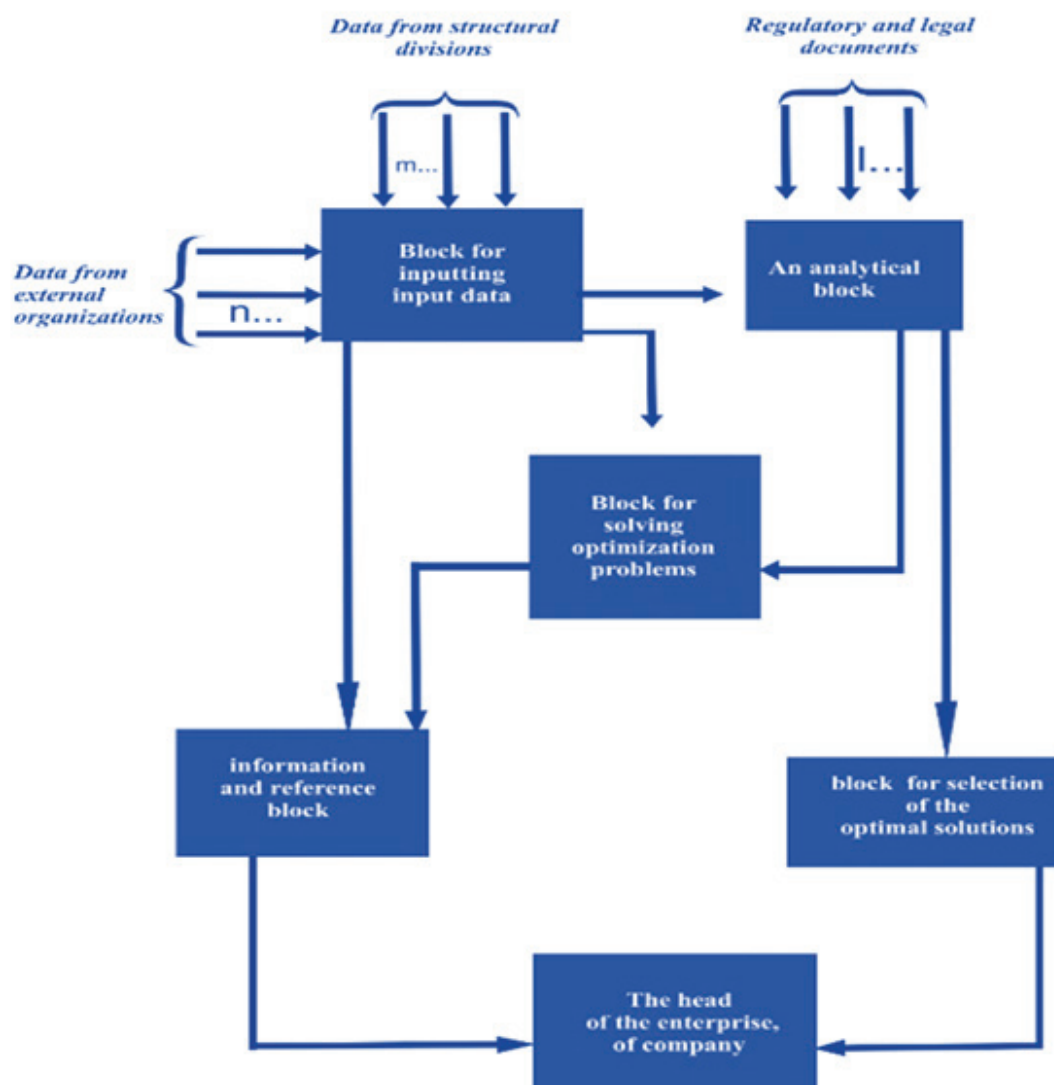
Figure 6 – Structure of the program robot manager

Note: Compiled by the authors.

The use of software robotic managers to manage the activities of enterprises, firms and companies will improve the quality of management functions, increase management efficiency, which will lead to an increase in profitability, competitiveness and profitability of these enterprises. Expanding the range of functions of robotic management will lead to the reduction of administrative and management personnel, increase labor productivity and improve other economic indicators of the enterprise [18].

The prospects for the development of digitalization and robotization are primarily related to the mining, metallurgical, and petrochemical industries. In the mining industry, the level of competitiveness of a company is determined primarily by productivity and operational excellence. Digitalization and robotization are becoming a determining factor that will enable mining companies to remain profitable and competitive in the future. Large enterprises in Kazakhstan, such as Kazakhmys, Kazminerals, Kazzinc, and Arcelor Mittal Temirtau, are robotizing mining operations. These companies have developed digital modernization plans; they are embarking on modernization programs such as "smart mine", where they will introduce new technologies: advanced sensors, sensors, robotics. These companies plan to invest about 800 billion tenge in digitalization and robotization projects in the coming years. Figures 7, 8 (p. 126) of the robotic mines are shown below.

Figure 7 – Robotic mine

Figure 8 – The Smart Mine

Conclusion

The most important catalyst for the new stage of digital transformation is the growing success in the development of advanced technological areas, including AI, robotics, blockchain, virtual and augmented reality technologies and a number of others. These technologies will provide consumers with unique opportunities, including highly accurate forecasting and data-driven management decisions, multiple cost reductions, and a better quality "customer experience.

Each industry plays its own unique role in the economy or social sphere. Each of them develops an individual, largely historically determined set of the most significant problems, challenges and tasks, forming its own development agenda.

There are a lot of obvious examples. For example, the fuel and energy sector and the chemical industry have the urgent task of reducing the negative impact on the environment. Certain digital solutions are in demand for its solution, including those that provide monitoring and control of the environmental situation and prompt response to emergencies. One of the peculiarities of the electric power industry is uneven power consumption. New digital solutions for power system management and distributed energy technologies help balance supply and demand and distribute energy more efficiently and promptly.

Agriculture is significantly dependent on weather and natural conditions. The intellectualization of agriculture (e.g., by introducing the concepts of precision farming, deep processing, smart farms, etc.) makes it possible to mitigate increasing agroclimatic risks. This kind of industry specificity largely determines the features of digitalization, as well as the prevailing trajectory and speed of digital transformation.

Digital transformation will require mastering new technologies and restructuring business processes accordingly. The transition to advanced solutions is gradual and is only possible with an updated material and technical base.

On the horizon of 5-10 years, fifth (5G) and sixth (6G) generation wireless networks due to high communication speed and low latency will radically change communication capabilities (up to the implementation of haptic Internet, telepresence and 3D-hologram transmission) and will create "growth points" in various sectors. New areas of application will become widespread: real-time monitoring and control of production processes through immersive audio-visual channels, complete "digitization" of all farm elements, real-time performance of routine operations by remotely controlled robots, etc.

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ПЕРСПЕКТИВЫ ЦИФРОВИЗАЦИИ
И РОБОТИЗАЦИИ ЭКОНОМИКИ КАЗАХСТАНА

Аннотация
Ключевым фактором развития казахстанской экономики является цифровая трансформация производственных предприятий, использование цифровых информационно-коммуникационных технологий для перестройки бизнеса таким образом, чтобы в нем все решения принимались на основе получаемых данных. Представлена структура цифровой трансформации. Для сбора, хранения, обработки, поиска и передачи данных в электронном виде применены сквозные цифровые технологии. Распространение технологий Интернета вещей и использование полученных от IoT- устройств данных в целях улучшения автоматизированных решений

и оптимизации промышленного производства играют важную роль при переходе к цифровому производству. Важнейшей задачей современных бизнес-моделей является создание омниканального пространства, синхронизация данных и информации во всех цифровых и физических каналах взаимодействия для удовлетворения потребностей клиентов в любое время и в любом месте. Перспективы развития цифровизации и роботизации экономики нашей республики связаны с разработкой и внедрением робототехнических средств. Важным направлением развития цифровизации и роботизации экономики нашей республики является разработка и применение программных роботов-менеджеров. Приводится структура программного робота-менеджера. Отмечается, что технологии цифровизации и роботизации предоставят казахстанским предприятиям уникальные возможности, в том числе высокую точность прогнозирования и принятия управленческих решений, основанных на данных, кратное снижение издержек, обеспечение лучшего качества «потребительского опыта».

Ключевые слова: цифровизация, роботизация, цифровая трансформация, экономика, бизнес-процессы, сквозные технологии, робот-менеджер.

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ҚАЗАҚСТАН ЭКОНОМИКАСЫН ЦИФРЛАНДЫРУДЫҢ ЖӘНЕ РОБОТТАНДЫРУДЫҢ БОЛАШАҒЫ

Аңдатпа

Қазақстан экономикасының дамуының шешуші факторы – өңдеуші кәсіпорындардың цифрлық трансформациясы, бизнесті барлық шешімдер алынған мәліметтер негізінде қабылданатындай етіп қайта құрылымдау үшін цифрлық ақпараттық-коммуникациялық технологияларды пайдалану. Цифрлық түрлендіру құрылымы ұсынылған. Өтпелі цифрлық технологиялар деректерді электронды түрде жинау, сақтау, өңдеу, іздеу және тасымалдау үшін қолданылады. IoT технологияларының таралуы және IoT құрылғыларынан алынған деректерді автоматтандырылған шешімдерді жақсарту және өнеркәсіптік өндірісті оңтайландыру үшін пайдалану цифрлық өндіріске көшуде маңызды рөл атқарады. Заманауи бизнес-модельдердің ең маңызды міндеті – кез келген уақытта және кез келген жерде тұтынушылардың қажеттіліктерін қанағаттандыру үшін барлық сандық және физикалық өзара әрекеттесу арналарында омниканалды кеңістікті құру, деректер мен ақпаратты синхрондау. Біздің республикамыздың экономикасын цифрландыру мен роботтандыруды дамыту перспективалары роботтық құралдарды әзірлеумен және енгізумен байланысты. Біздің республикамыздың экономикасын цифрландыру мен роботтандыруды дамытудың маңызды бағыты робот-менеджерлерді бағдарламалық қамтамасыз етуді әзірлеу және қолдану болып табылады. Бағдарламалық қамтамасыз ету робот-менеджерінің құрылымы берілген. Цифрландыру және роботтандыру технологиялары қазақстандық кәсіпорындарға бірегей мүмкіндіктерді, соның ішінде деректер негізінде болжау мен басқару шешімдерін қабылдаудың жоғары дәлдігін, шығындарды еселеп азайтуды және «тұтынушы тәжірибесінің» ең жақсы сапасын қамтамасыз ететіні атап өтілді.

Тірек сөздер: цифрландыру, роботтандыру, цифрлық трансформация, экономика, бизнес-процестер, өтпелі технологиялар, робот-менеджері.