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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 used to collect, store, process, search, transmit and present data electronically are considered. The proliferation of IoT technologies and the use of data from IoT devices to make (improve) automated decisions and optimize industrial production play a significant 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".

Keywords: digitalization, robotization, digital transformation, economy, business processes, end-to-end technologies, robot manager.

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ҚАЗАҚСТАН ЭКОНОМИКАСЫН ЦИФРЛАНДЫРУДЫҢ ЖӘНЕ РОБОТТАНДЫРУДЫҢ БОЛАШАҒЫ

Аннотация. Қазақстан экономикасының дамуының шешуші факторы – өндеуші кәсіпорындардың цифрлық трансформациясы, бизнесті барлық шешімдер алынған мәліметтер негізінде қабылданатындай етіп қайта құрылымдау үшін цифрлық ақпараттық-коммуникациялық технологияларды пайдалану. Цифрлық түрлендірудің құрылымы ұсынылған, деректерді жинау, сақтау, өңдеу, іздеу, беру және электронды түрде ұсыну үшін қолданылатын «end-to end» цифрлық технологиялары қарастырылады. Цифрлық өндіріске көшуде технологиялардың таралуы маңызды рөл атқарады. Цифрлық өндіріске көшуде маңызды рөлді «Заттардың интернеті» технологияларының таралуы және автоматтандырылған шешімдерді қабылдау (жетілдіру) және өнеркәсіптік өндірісті оңтайландыру үшін IoT құрылғыларынан алынған деректерді пайдалану 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 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.

Түйін сөздер: цифрландыру, роботтандыру, цифрлық трансформация, экономика, бизнес-процестер, «end-to end» технологиялар, робот-менеджері.

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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, рассмотрены сквозные цифровые технологии, применяемые для сбора, хранения, обработки, поиска, передачи и представления данных в электронном виде. Значимую роль в переходе к цифровому производству играет распространение технологий Интернета вещей и использование полученных с IoT-устройств данных для принятия (улучшения) автоматизированных решений и оптимизации промышленного производства.

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

Introduction

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 ability to process and analyze large volumes 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.

In recent years, another wave of transformation of business and social models has been unfolding, caused by the emergence of a new generation of digital technologies, which due to their scale and depth of influence have been called "end-to-end" - artificial intelligence, robotics, the Internet of Things, wireless communication technologies and a number of others. Their implementation, according to experts, is capable of increasing labor productivity in companies by 40%. In the near future, it is the effective use of new digital technologies that will determine the international competitiveness of both individual companies and entire countries that form the infrastructure and legal environment for digitalization.

Purpose of the study

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.

Methodology

A key factor in the development of Kazakhstan's economy is the digital transformation of manufacturing enterprises.

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 construction [1].

Result

Figure 1 shows the structure of digital transformation.

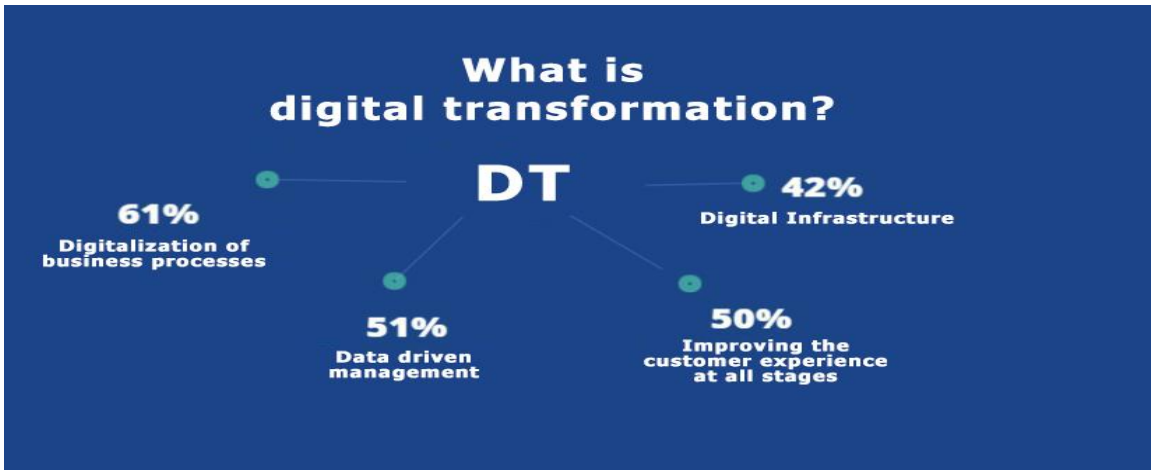

Figure 1 - Structure of digital transformation

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.

Digital transformation involves the widespread use of end-to-end digital technologies. End-to-end digital technologies are technologies used to collect, store, process, search, transmit and

presentation of data in electronic form, the functioning of which is based on software and hardware tools and systems that are in demand in all sectors of the economy, creating new markets and changing business processes. These include [2]

1. Big data - technologies for collecting, processing and storing structured and unstructured arrays of information characterized by a significant volume and characterized by significant volume and rapid rate of change (including in real time), which requires special tools and methods of working with them.

2. The artificial intelligence is a system of software and/or hardware capable of a certain degree of autonomy to perceive information, learn and make decisions based on the analysis of large amounts of data, including simulating human behavior.

3. *Distributed ledger technologies (blockchain*) - algorithms and protocols for decentralized storage and processing transactions structured as a sequence of linked blocks without the possibility of their subsequent modification.

4.Quantum technologies - technologies of creation of computing systems based on new principles (quantum effects), allowing to radically change the ways of transmission and processing of large data arrays.

5. New production technologies - technologies of digitalization of production processes, which provide increased efficiency of use of resources, design and manufacture of individualized objects, the cost of which is comparable with the cost of mass-produced goods.

6. Additive technologies - technologies of layer-by-layer creation three-dimensional objects on the basis of their digital models ("twins"), which allow manufacturing products of complex geometric shapes and profiles.

7. Industrial Internet - data networks connecting devices in the industrial sector, equipped with sensors and capable of interacting with each other and/or the external environment without human intervention.

8. Components of robotics (industrial robots) -

мmanufacturing systems with three or more degrees of mobility (freedom), based on sensors and artificial intelligence, capable of perceiving the environment, controlling their actions and adapting to its changes. Sensorics - technologies for creating devices that collect and transmit information about the state of the environment through data networks.

9. Wireless communication technologies - technologies for transmitting

data transmission through a standardized radio interface without the use of a wired network connection. 5G - Fifth generation wireless communication technologies, characterized by high bandwidth (at least 10 Gbit/s), reliability and security of the network, low data transmission latency (less than one millisecond), and, as a result, it becomes possible to efficiently use big data.

10. Virtual reality technologies are technologies of computer modeling of three-dimensional image or space, by means of which a person interacts with synthetic ("virtual") environment with subsequent sensory feedback.

11. Augmented reality technologies - visualization technologies based on adding information or visual effects to the physical world by overlaying graphical and/or audio content to enhance the user experience and interactive capabilities.

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 [3].

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process management (MOS/MES) and product lifecycle management (PLM) systems, as well as further maintenance.

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 $. [4].

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 [5]**.** Digital twin technology, which combines the industrial Internet of Things and digital modeling, is being actively implemented in developed countries at 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 [6]. The introduction of "digital twins" for modeling and evaluating various scenarios will reduce the number of equipment failures by an average of 30% [7].

Digital services and the modern approach to the development of "smart" spaces

change the human living conditions to a more comfortable. "Smart spaces are physical or digital environments in which people and technological systems openly interact in connected and coordinated smart ecosystems. 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.

The main parameter of competitiveness of new business models is the speed of bringing a new product to market (timeto-market). Modern product development and manufacturing approaches based on advanced manufacturing technologies make it possible to reduce time-to-market and use an iterative approach to updates and improvements, adapting to changing customer needs by making it easy to change suppliers and testing new concepts and products (e.g., Tesla launches new options and fixes claims in real time, remotely via software updates; Facebook tests and launches updates for select user groups twice a day, etc.) [8].

The most important task of modern business models is 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.

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

The widespread application of robotics in industry will greatly complicate and diversify the production sector. 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 [9]. Pictures 1 and 2 show robotics used in industrial plants.

Photo 1 - Robotic car assembly area

Photo 2 - 3D house construction with robots.

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.).

The advantages of using robotics in agriculture are as follows:

- 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 photos 3 and 4).

Photo 3 - Robot sprayer

Photo 4 - robotic cultivator

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 [10].

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 (Fig. 2) [11]:

- 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, on the progress of the production program, on the progress of product sales, etc.

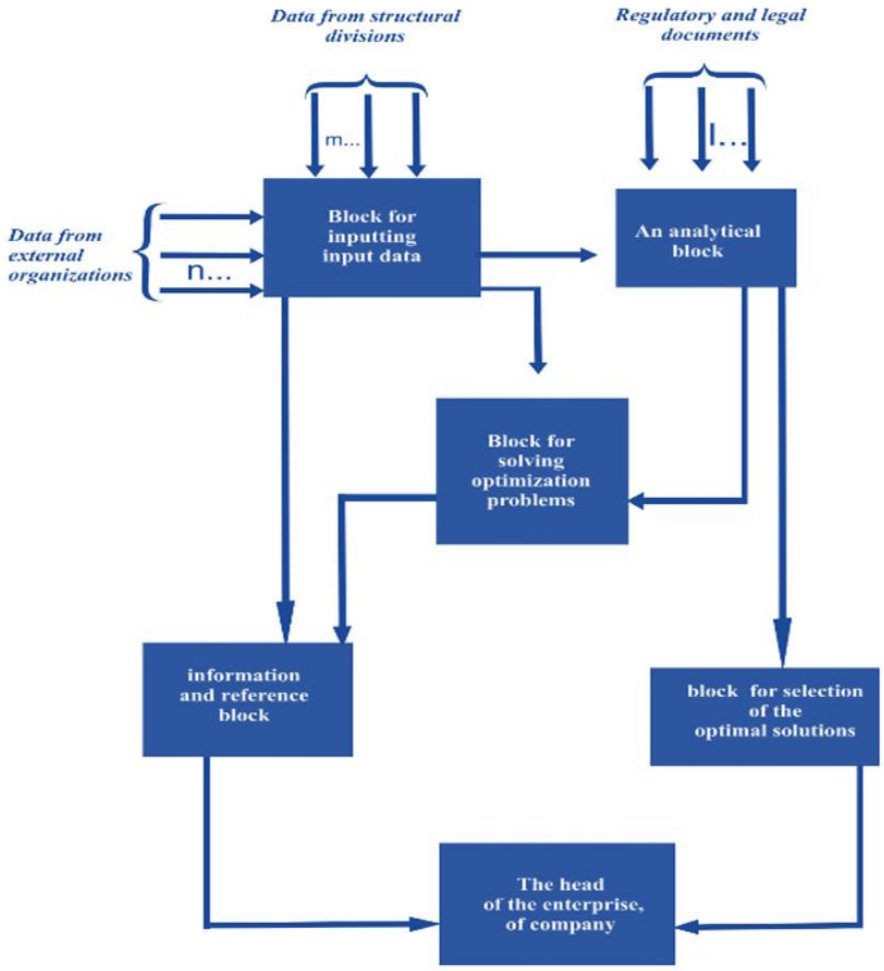

Figure 2 - Structure of the program robot manager

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 [12].

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.

Conclusions

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.

REFERENCES

1. М.Ф.Баймухамедов, А.М.Баймухамедова. Цифровизация и роботизация экономики. // Монография, издательство «Lambert Academic Publishing», 2022. – 116 с.

2.Andreasson K.J. Digital Divides: The New Challenges and Opportunities of E-Inclusion. CRC Press, 2015. - 328 p.

3.Т. В. Куладжи, А. В. Бабкин, С. Ю. Муртазаев Использование матричного инструментария в цифровой экономике для оценки производства промышленной продукции // Цифровая трансформация экономики промышленности: проблемы и перспективы / под ред. А. В. Бабкина.– СПб.,2017.–С. 686–727.

4. Global 2000 – крупнейшие публичные кампании мира в 2020 г. //https://www.forbes.com/global2000/#42998f69335d.

5. Mogstad, I. The Digitalization Opportunity Executives Can't Afford to Miss [Электронный ресурс]. – Электрон. дан. – EDF, 2019. – Режим доступа: https://www.edf.org/blog/2019/02/14/digitalization-opportunity-executives-cant-afford- miss.

6. The Digital Twin: Powerful Use Cases for Industry 4.0. Data Driven Investor [Электронный ресурс]. – Электрон. дан. – Medium, 2018. - Режим доступа: https://medium.com/datadriven investor/the-digital-twin-powerful-use-cases-for- industry-4-0-cdf5b0ebf8ae.

7. Immerman D. Digital Twin Predictions: The Future Is Upon Us [Электронный ресурс]. – Электрон. дан. – PTC, 2019. - Режим доступа: https://www.ptc.com /en/product-lifecycle-report/digital-twin-predictions.

8. P. Weill and S.L. Woerner. Thriving in an increasingly digital ecosystem. // MIT Sloan Management Review. 56(4),2015. -pp.:27-34.

9. Баймухамедов М.Ф., Боранбаев А.С., Боранбаев С.Н. Робототехника. // Учебник, том 2 (на казахском, английском и русском языках), изд-во «Бастау», Алматы, 2021 г. – 289 с.

10. Баймухамедов М. Ф., Аймурзинов М. С., Тажиева Ш. Ж. Применение робототехники в сельском хозяйстве. // Материалы международной

конференции «Наука и образование в современном мире: вызовы XXI века». Нур-Султан, 22 апреля 2021 г. - С.112-116.

11. Baimukhanov, A.M. Baimukhamedova, M.F. Baimukhamedov, G.S. Baimukhamedova. Some aspects of robotization of the economy and creation of a robot manager. // Vestnik KazNU. Seriya ekonomicheskaya. № 3(137) (2021). - S.139-146.

12. Баймухамедов М.Ф., Баймухамедова А.М., Баймухамедова Г.С., Аймурзинов М.С. Цифровая трансформация предприятий в условиях цифровизации экономики // Вестник Карагандинского университета. Серия «Экономика». – 2021. – Т.104. № 4. – С. 108-116.

REFERENCES

1. M.F. Baymukhamedov, A.M. Baymukhamedova. Tsifrovizatsiya i robotizatsiya ekonomiki. // Monografiya, izdatel'stvo «Lambert Academic Publishing», 2022. – 116 s. [in Russian].

2.Andreasson K.J. Digital Divides:The New Challenges and Opportunities of E-Inclusion. CRC Press, 2015. - 328 p.

3. T. V. Kuladzhi, A. V. Babkin, S. YU. Murtazayev. Ispol'zovaniye matrichnogo instrumentariya v tsifrovoy ekonomike dlya otsenki proizvodstva promyshlennoy produktsii // Tsifrovaya transformatsiya ekonomiki promyshlennosti: problemy i perspektivy / pod red. A. V. Babkina. [The use of matrix tools in the digital economy to assess the production of industrial products // Digital transformation of the industrial economy: problems and prospects / ed. A. V. Babkina] (Polytechnic University Press, SPb,2017) [in Russian].

4. Global 2000 – krupneyshiye publichnyye kampanii mira v 2020 g. [Global 2000 - the world's largest public campaigns in 2020]. [Electronic resource] – Available at://https://www.forbes.com/global2000/#42998f69335d.forbes.(Accessed: 18.10.2020).

5. Mogstad, I. The Digitalization Opportunity Executives Can't Afford to Miss [Electronic resource] Available at: https://www.edf.org/blog/digitalization-opportunity-executives-cant-afford- miss Accessed: 14.02.2019).

6. The Digital Twin: Powerful Use Cases for Industry 4.0. Data Driven Investor [Electronic resource] - Available at: https://medium.com/datadriven-investor/the-digital-twin-powerful-use-cases-for-industry-4-0-cdf5b0ebf8ae (Accessed: 11.06.2018).

7. Immerman D. Digital Twin Predictions: The Future Is Upon Us [Electronic resource] Available at: https://www.ptc.com /en/product-lifecycle-report/digital-twin-predictions (Accessed: 9.01.2019).

8. P. Weill and S.L. Woerner. Thriving in an increasingly digital ecosystem. // MIT Sloan Management Review. 56(4),2015. -pp.:27-34.

9. Baymukhamedov M.F., Boranbayev A.S., Boranbayev S.N. Robototekhnika. [Robotics] (Bastau, Almaty, 2021).

10. Baymukhamedov M. F., Aymurzinov M. S., Tazhiyeva Sh. Zh. Primeneniye robototekhniki v sel'skom khozyaystve [Application of robotics in agriculture] Tezisy dokladov Mezhdunarodnoj konferencii "Nauka i obrazovaniye v

sovremennom mire: vyzovy XXI veka" [International conference on science and education in the modern world - challenges of the 21st century] Nur-Sultan, 2021, pp.112-116.

11. Baymukhanov, A.M. Baymukhamedova, M.F. Baymukhamedov, G.S. Baymukhamedova. Some aspects of robotization of the economy and creation of a robot manager. Vestnik KazNU. Seriya Ekonomicheskaya [The Journal of Economic Research & Business Administration], **3** (137), 139-146 (2021).

12. Baymukhamedov M.F., Baymukhamedova A.M., Baymukhamedova G.S., Aymurzinov M.S. Tsifrovaya transformatsiya predpriyatiy v usloviyakh tsifrovizatsii ekonomiki [Digital transformation of enterprises in the context of digitalization of the economy], Vestnik Karagandinskogo universiteta. Seriya Ekonomika [Bulletin of the Karaganda University], 4 (104), 108-116 (2021) [in Russian].