INNOVATIVE MANAGEMENT SYSTEM FOR AGRO-INDUSTRIAL COMPLEX FACILITIES WITHIN THE FRAMEWORK OF THE "INDUSTRY -5.0" CONCEPT

«ИНДУСТРИЯ-5.0» ТҰЖЫРЫМДАМАСЫ ШЕҢБЕРІНДЕ АГРОӨНЕРКӘСІПТІК КЕШЕН ОБЪЕКТІЛЕРІН БАСҚАРУДЫҢ ИННОВАЦИЯЛЫҚ ЖҮЙЕСІ

ИННОВАЦИОННАЯ СИСТЕМА УПРАВЛЕНИЯ ОБЪЕКТАМИ АГРОПРОМЫШЛЕННОГО КОМПЛЕКСА В РАМКАХ КОНЦЕПЦИИ «ИНДУСТРИЯ-5.0»

A.M. BAIMUKHAMEDOVA[1]*
DBA
M.S. AIMURZINOV [2]
C.E.Sc.
G.S. BAIMUKHAMEDOVA[2]
C.E.Sc.
[1]*Gazi University, Ankara, Türkiye*
[2] *Z. Aldamzhar Kostanay Socio-Technical University, Kostanay, Kazakhstan*
corresponding author e-mail: gulzda48@mail.ru

А.М. БАЙМҰХАМЕДОВА[1]*
ІӘД
М.С. АЙМУРЗИНОВ[2]
э.ғ.к.
Г.С. БАЙМҰХАМЕДОВА[2]
э.ғ.к.
[1]*Гази университеті, Анкара, Түркия*
[2]*З.Алдамжар атындағы Қостанай әлеуметтік-техникалық университеті,
Қостанай, Казахстан*
автордың электрондық поштасы: gulzda48@mail.ru

А.М. БАЙМУХАМЕДОВА[1]*
ДБА
М.С. АЙМУРЗИНОВ[2]
к.э.н.
Г.С. БАЙМУХАМЕДОВА[2]
к.э.н.
[1]*Гази университет, Анкара, Турция*
[2]*Костанайский социально-технический университет им. З. Алдамжар,
Костанай, Казахстан*
электронная почта автора: gulzda48@mail.ru

Annotation. *The goal* is to outline main provisions of the concepts "Industry 4.0" and "Industry 5.0", to show main directions of digital transformation of agricultural facilities and the fifth industrial revolution. *Methods* – systematic approach, comparative analysis, expert-analytical. *Results* - it is noted that the main component of Industry 5.0 is the widespread use of robots, cobots, big data technologies, blockchain and artificial intelligence in production processes. One of the promising trends in the development of digital economy within the framework of Industry 5.0 projects is creation and implementation of robot managers used in management of firms, enterprises, and business structures. A block diagram of robot manager and description of the work are presented, blocks for inputting incoming information from divisions of economic entity and analytical one that provides statistical and dynamic data analysis, model for solving optimization coordination problems based on theory of optimal management, methods and models of artificial intelligence, fuzzy logic and neural networks, blocks for developing various options for the results of management actions and selecting the most acceptable one, and information and reference blocks, allowing the manager to have the necessary information about

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the state of production and economic activities. *Conclusions* - spread of robot managers in agricultural sector will ensure the use of end-to-end digital technologies: big data, algorithmic intelligence, distributed registry technologies (blockchain), additive technologies, wireless communication technologies, etc. The use of robot managers in agricultural sector will create favorable conditions for increasing profitability of production, improvement of its economic indicators. Their development is aimed at reducing current production costs and production costs, which in the current economic conditions is a priority need for agricultural producers in order to positively change the financial condition of their functioning.

Аңдатпа. *Мақсаты* - «Индустрия-4.0» және «Индустрия-5.0» тұжырымдамаларының негізгі ережелерін баяндау, агроөнеркәсіптік кешен объектілері мен бесінші өнеркәсіптік революцияның цифрлық трансформациясының негізгі бағыттарын көрсету. *Әдістері* - жүйелік тәсіл, салыстырмалы талдау, сараптамалық-аналитикалық. *Нәтижелері* - «Индустрия-5.0» негізгі құрамдас бөлігі роботтарды, коботтарды, үлкен деректер технологияларын, блокчейнді және жасанды интеллектті өндірістік процестерде кеңінен қолдану болып табылады. «Индустрия-5.0» жобалары шеңберінде цифрлық экономиканы дамытудың перспективалық үрдістерінің бірі фирмаларды, кәсіпорындарды, бизнес-құрылымдарды басқаруда пайдаланылатын робот-менеджерлерді құру және енгізу болып табылады. Робот-менеджердің құрылымдық схемасы және жұмыс сипаттамасы, шаруашылық жүргізуші субъектінің бөлімшелерінен кіріс ақпаратын енгізу блоктары және деректерді статистикалық және динамикалық талдауды қамтамасыз ететін аналитикалық, оңтайлы басқару теориясы, жасанды интеллект әдістері мен модельдері, анық емес логика және нейрондық желілер негізінде үйлестірудің оңтайландыру мәселелерін шешу моделі, басқару әрекеттері мен таңдау нәтижелерінің әртүрлі нұсқаларын әзірлеу блоктары ұсынылған олардың ішіндегі ең қолайлысы және ақпараттық-анықтамалық, басшыға өндірістік-шаруашылық қызметтің жай-күйі туралы қажетті мәліметтерді иеленуге мүмкіндік береді. *Қорытындылар* - аграрлық секторда Робот-менеджерлерді тарату сандық технологияларды пайдалануды қамтамасыз етеді: үлкен деректер, алгоритмдік интеллект, таратылған тізілім технологиялары (блокчейн), аддитивті технологиялар, сымсыз байланыс технологиялары және т.б. ауыл шаруашылығы саласында Робот-менеджерлерді тарту өндірістің рентабельділігін арттыру, оның экономикалық көрсеткіштерін жақсарту үшін қолайлы жағдайлар жасайды. Оларды игеру өндірістің ағымдағы шығындарын және өнімнің өзіндік құнын төмендетуге бағытталған, бұл қалыптасқан экономикалық жағдайда олардың жұмыс істеуінің қаржылық жағдайын оң өзгерту мақсатында ауыл шаруашылығы тауарын өндірушілер үшін бірінші кезектегі қажеттілік болып табылады.

Аннотация. *Цель* – изложить основные положения концепций «Индустрия-4.0» и «Индустрия-5.0», показать основные направления цифровой трансформации объектов агропромышленного комплекса и пятой промышленной революции. *Методы* – системного подхода, сравнительного анализа, экспертно-аналитический. *Результаты* – отмечается, что основная составляющая «Индустрии-5.0» – широкое применение в производственных процессах роботов, коботов, технологий больших данных, блокчейна и искусственного интеллекта. Одной из перспективных тенденций развития цифровой экономики в рамках проектов «Индустрия-5.0» является создание и внедрение роботов-менеджеров, используемых в управлении фирмами, предприятиями, бизнес-структурами. Представлена структурная схема робота-менеджера и описание работы, блоки ввода входящей информации от подразделений хозяйствующего субъекта и аналитический, обеспечивающий статистический и динамический анализ данных, модель решения оптимизационных задач координации на основе теории оптимального менеджмента, методов и моделей искусственного разума, нечеткой логики и нейронных сетей, блоки разработки различных вариантов результатов управленческих действий и выбора наиболее приемлемого из них и информационно-справочный, позволяющий руководителю владеть необходимыми сведениями о состоянии производственно-хозяйственной деятельности. *Выводы* – распространение роботов-менеджеров в аграрном секторе обеспечит использование сквозных цифровых технологий: большие данные, алгоритмический интеллект, технологии распределенного реестра (блокчейн), аддитивные технологии, технологии беспроводной связи и др. Задействование роботов-менеджеров в сфере сельского хозяйства создаст благоприятные условия для повышения рентабельности производства, улучшения его экономических показателей. Их освоение направлено на снижение текущих затрат производства и себестоимости продукции, что в сложившихся экономических условиях – первоочередная необходимость для сельхозтоваропроизводителей с целью позитивного изменения финансового состояния их функционирования.

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Introduction. The fourth industrial revolution has brought technological and economic changes to our modern life with the integration of innovations such as artificial intelligence, blockchain, internet of things, cryptocurrencies, robotics, etc.

The fifth industrial revolution, Industry 5.0, is a further development of Industry 4.0 and is based on smart technologies. It underpins all the achievements of the economy and essentially considered eight critical areas: Value addition; Augmented reality; Autonomous robots; Big data and analytics; Cloud connectivity; Cybersecurity; Internet of things; Modeling and digital twins.

According to researchers at Australia's Deakin University, the fifth industrial revolution involves bringing workers back to the factory floor and combining human intelligence, creativity with machine capabilities to make processes more efficient [1]. While the main challenge in Industry 4.0 is automation, Industry 5.0 envisions a synergy between humans and autonomous machines.

Industry 5.0 will change the definition of the word robot. Robots, which by 2021 are perceived solely as a programmable machine that can perform repetitive tasks, will evolve into the ideal human companion to perform tasks in some scenarios. The next industrial revolution will introduce the next generation of robots, commonly referred to as cobots, which will already know or be able to quickly learn what to do, in conjunction with humans. These robots will be "aware" of the presence of humans, so they will be able to take care of safety criteria and will take into account various work risks. They will notice, understand and sense not only the human, but also the goals and expectations of the human operator.

Like a learner, the cobots will observe and learn how the human performs the task. Once trained, the cobots will perform the desired tasks in the same manner as the human operators. It is expected that the human will experience a sense of satisfaction when working alongside the cobots.

Material and methods of research. The main feature of Industry 5.0 is the widest possible use of robots, cobots, big data, blockchain and artificial intelligence in production processes. This is due to the transition to digital technologies that allow decisions to be made based on real-time data about production processes. In turn, this allows to reduce production costs, improve product quality, and ensure rapid production of goods that meet current market demands [2].

The integration of robots and cobots into manufacturing will simplify automation and create true human-robot collaboration. When skilled labor becomes scarce, this collaboration will continue to operate efficiently and productively despite changes in the workforce. The principles of continuous self-development and self-learning will come to the forefront for manufacturing employees. Corporate cultures will be built around supporting education, creativity, and out-of-the-box thinking for robotic employees.

Robots will push and supplement this never-ending process of development. Technology is not going to slow down, and it is likely that technology development will be even faster and more intense as the years go by. By utilizing technology, manufacturing employees will ultimately benefit. Industry 5.0 will create a collaborative environment that will impact efficiency and effectiveness in most aspects of manufacturing. The effects of Industry 5.0 should ultimately be positive. But for this to happen, it is necessary already today to reorganize the system of maintenance and repair, personnel management, and production funds in general.

Results and their discussion. One of the most important components of Industry 5.0 will be the human-machine interface. Robots will learn from humans, and humans will benefit from robots performing tasks that humans cannot or will not perform as part of manufacturing operations. Combining human intelligence with the cognitive abilities of a technologically advanced working partner is a

powerful combination designed to deliver high performance.

Digital transformation and robotization have proven themselves in many areas of human activity and have promising development prospects. Robotics complexes (RTC) are used in enterprises to automate the production process, during emergencies for prompt and safe assistance) [3].

The application of digital technologies and robotics is associated with process optimization - cost and time reduction, as well as qualitative improvement of the result. For example, application in automobile plants reduces the production cycle, improves product quality, and eliminates the factor of human error.

Modern technology is dramatically changing more and more industries, from manufacturing to entertainment. But why do businesses need digital transformation? And how can it be done correctly? The answers to these questions can be found in the heads of well-known international and Russian companies. The authors of the paper [4] explain why in the digital era the survival of business directly depends on its ability to quickly adapt to the needs of customers and why changes are needed even where everything is already good.

The methodology of digital business transformation has been tested by hundreds of small and medium-sized business leaders around the world [5,6]. It is based on the research of the American MIT University on the impact of technology on management. Based on data from the Center for Information Technology Research at the Sloan School of Management at the Massachusetts Institute of Technology, the authors of the paper [7] concluded that digitalization forces companies to move from value chains to ecosystems and achieve a deeper understanding of the needs of end consumers.

Peter Weil and Stephanie Warner [8] suggest auditing your company, moving to a deep understanding of your end customers, and creating a clear action plan to develop a profitable digital ecosystem. This is what the largest employers of Western companies are now striving for.

How does the introduction of artificial intelligence affect business? Will robots replace humans? And which industries will be automated first? These questions are answered by Ravin Jesuthasan and John Boudreau, recognized experts on human resources management in the digital age, in their paper "Reengineering Business. How to Competently Implement Automation and Artificial Intelligence" [9]. They do not limit themselves to theory alone, but offer their own model of transformation, with the help of which companies can find the optimal combination of machine and human labor.

Tom Siebel - one of Silicon Valley's most prominent entrepreneurs and leaders - has compiled in his astounding book, "Digital Transformation. How to Survive and Succeed in the New Era" [10]. Here is the knowledge of all the important digital technologies that every executive must master: big data, the Internet of Things, cloud computing and, of course, artificial intelligence. It engages us in an interesting discussion of changing technologies, and provides a roadmap on how to capitalize on new opportunities for digital transformation in business.

The development of an innovative system of management of AIC objects within the framework of the "Industry -5.0" concept will be based on digital transformation and robotization of enterprises.

Digital transformation is the restructuring of technologies, business models and processes that ensure the formation of new values for customers and employees in a constantly changing economic environment in order to develop the digital economy [11,12]. These processes place new demands on manufacturing companies, forcing them to implement elements of digitalization. Their importance for businesses is obvious, as they promote scientific and technological progress, open up opportunities for growth and sustainable competitiveness, affecting the entire production and supply chain.

In addition, there is a direct correlation between the digitalization of business and its profitability. McKinsey Global Institute estimates that productivity is significantly higher in digitized sectors due to data-driven business models and the use of end-to-end digital technologies. Therefore, companies around the world are favoring digital technologies. Thus, experts predict that 30% of firms from the Global 2000 list (the largest public companies in the world in 2020) will allocate at least 10% of their revenues to finance their digital strategy [13].

In today's environment, organizations need to look at their own business with a digital economy approach in mind. 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 become an end in itself. It is

necessary to calculate the effectiveness of certain changes in order to be sure that key processes in the company will improve significantly as a result of digitalization.

Below we explain what digital transformation means for manufacturing companies (figure 1).
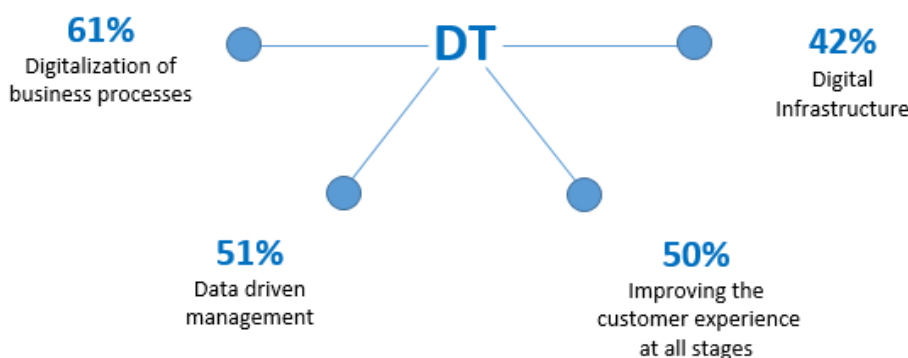
Note: compiled by the authors

Figure 1 - Digital transformation

For economic entities, this means:
● digitalization of business processes: doing faster and more with the same resources;
● data-driven management: know the exact figures and quickly remove the unprofitable;
● improving the customer experience at all stages: correct human errors and do before the sale;
● digital infrastructure: utilize modern digital technologies and tools.

Digital transformation research includes hands-on training for digital transformation enterprises, hands-on training and consulting services for digital transformation of production lines.

Manufacturing enterprises should conduct digital usage level analysis and digital maturity level analysis, and determine the digitalization program to be applied in the enterprise.

The main objectives of digital transformation are [14]:
* ensuring the continuity and sustainability of productivity practices in enterprises;
* ensuring an integrated digital production structure including management and production processes in enterprises;
* ensuring business transformation with the outside world in digital harmony and digital interoperability;
* prepare businesses for the transformation of Industry 4.0;
* increase the capacity of digital transformation training and consulting services at the local level;
* identify the performance levels of businesses and make them ready to apply the performance certificate;

* train digital transformation practitioners (technology integrators) at the local level.

Each business may require unique digital solutions. Digital transformation requires the simultaneous transformation and management of many different elements (people, processes and technology). Accordingly, the requirements that should be applied prior to the transformation process are as follows:
■ performance diagnostic study;
■ measurement of process analysis levels;
■ measurement of digitalization maturity levels;
■ preparation of a digital transformation roadmap.

With these tools, it is necessary to determine the most appropriate solution for the business so as not to deviate from the goal of digital transformation.

One of the promising areas of development of the digital economy within the framework of the concept of "Industry 5." is the robotization of production process management systems, namely the creation of robot managers used in the management of AIC objects - firms, enterprises, business structures.

Creation and introduction of robot managers into the sphere of economy will allow to realize the following management functions [15]:
- planning and forecasting of enterprise activity;
- accounting of human, material, technical, financial, natural and other resources;
- control over the implementation of management decisions, over the course of technological processes, over the course of realization and sales of products, over the fulfillment of contractual and other obligations, etc.;

- analysis of the main indicators of implementation of production programs of the firm, company, input and output information related to the company's activities, current and planned state of the company's activities;

- coordinating the activities of structural subdivisions of the firm, enterprise, company;

optimal regulation of financial, production, foreign economic, legal and social-insurance activities of the company.

Figure 2 shows a block diagram of the robot manager.
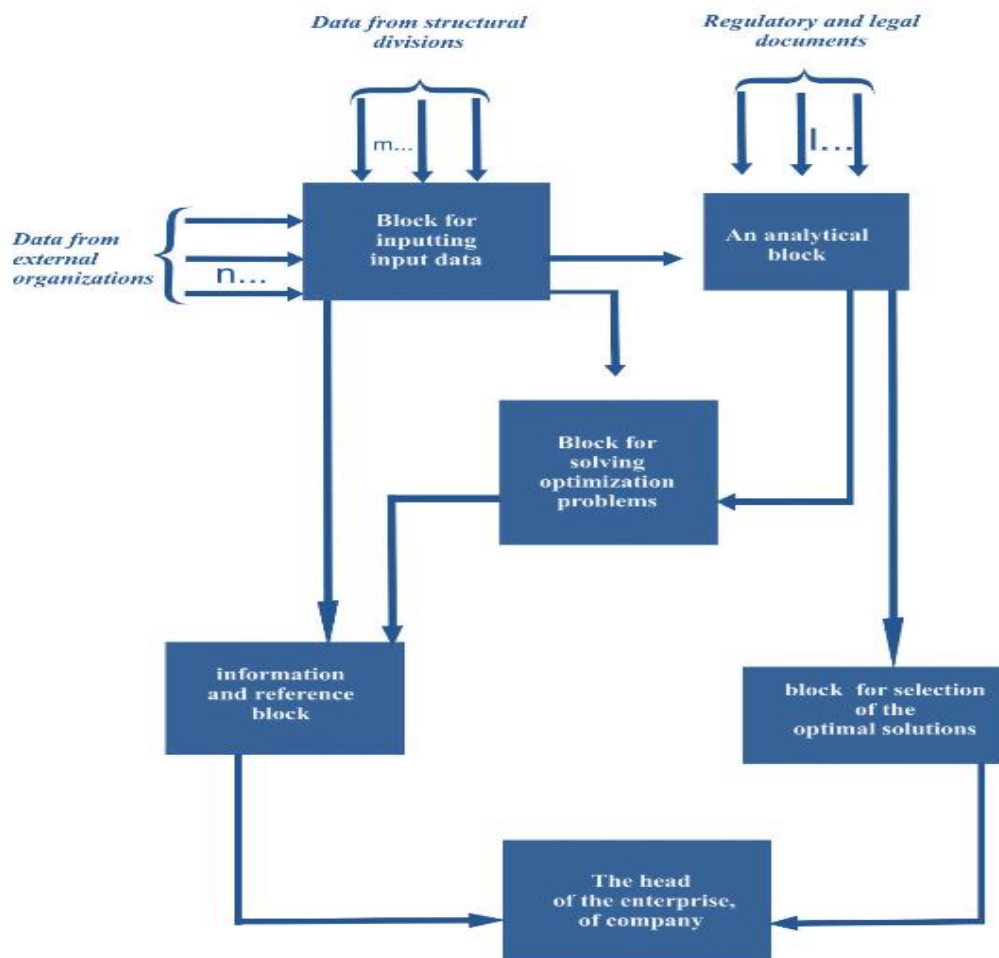
Note: compiled by the authors

Figure 2 - Block diagram of the robot manager.

The structure of the robot manager includes the following main blocks [12]:

● block of input of incoming information from structural subdivisions of the enterprise, organization;

● analytical block that provides static and dynamic analysis of data coming from the block that inputs incoming information from structural units of the enterprise, from sensor equipment, video cameras and other devices for collecting data on the activities of the enterprise;

● block for solving optimization control problems based on the application of the theory of optimal control, methods and models of

artificial intelligence, fuzzy logic and neural networks;

● block of development of variants of management decisions and selection of the optimal decision;

● information and reference block that provides the head of the enterprise or organization with necessary information on the state of production and economic activity, on the progress of the production program, on the progress of product sales, etc.

The input block receives data including complete information on production activities of all structural units of the enterprise or organization. These data are structured in a cer-

tain way, fed into the analytical block and the information and reference block. The analytical block receives data including regulatory and legal materials, information on the state of the enterprise's activities, the progress of sales of manufactured products, fulfillment of contractual obligations, etc. The information input block also receives data including information on production relations with external organizations, international relations and co-operation, etc.

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

The introduction of robot managers will ensure the use of end-to-end digital technologies: Big Data, Artificial Intelligence, distributed registry technologies (blockchain), additive technologies, wireless communication technologies, etc.

Conclusion.

1. Digitalization, intellectualization and robotization of the economy have truly become a global challenge of our time. At present, the idea of digital transformation and robotization is sweeping the world and in many countries this idea is a strategic development priority.

2. The set of phenomena that we characterize as digital transformation, intellectualization and robotization is the central element of the so-called fifth technological revolution. A wide range of economic and social sectors, which have remained fundamentally unchanged for many decades, are undergoing a profound transformation, essentially becoming high-tech in the broad sense of the word. However, it would be fundamentally mistaken to look at this process solely from the angle of technological development. New models of economic activity are emerging, which means that economic and social institutions are undergoing strong changes.

3. Digital transformation is a complex, by no means routine and in many ways poorly predictable process, covering many spheres of life and for its successful implementation it requires the fulfillment of a number of fundamental conditions, including technological and managerial preparedness of organizations and markets.

4. The application of digital technologies and robotics at AIC enterprises provides optimization of the production process - cost and time reduction, as well as qualitative improvement of the result. The creation of robot managers applied in the management of AIC objects - firms, enterprises, business structures, will reduce production costs, improve the quality of products, ensure the rapid release of goods that meet current market demands.

5. According to the forecasts of leading world experts, by 2025 70% of the world economy will be digital, and the introduction of digitalization technologies of the economy, allowing the state, business and society to interact effectively, is becoming an increasingly large-scale and dynamic process [16].

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Information about authors:

Baimukhamedova Aizhan Malikovna – **The main author;** Doctor of Business Administration; Professor of Gazi University; 06560 Yenimahalle, Emniet, Silahtar Str., 17, Ankara, Türkiye; e-mail: gulzada48@mail.ru; https://orcid.org/0000–0002–2358–0007

Aymurzinov Murat Saparjanovich; Candidate of Economic Sciences; Associate Professor of the Department of Economics; Z. Aldamzhar Kostanay Social -Technical University; 110000 Kobylandy Batyr Ave., 27, Kostanay, Kazakhstan; e-mail: ams-66@mail.ru; https://orcid.org/0000–0003–1287–8913

Baimukhamedova Gulzada Seiduvalievna; Candidate of Economic Sciences; Associate Professor of the Department of Economics; Z. Aldamzhar Kostanay Social-Technical University; 110000 Kobylandy Batyr Ave., 27, Kostanay, Kazakhstan; e-mail: djanin65@gmail.com. https://orcid.org/0000–0002–3689–4224

Авторлар туралы ақпарат:

Баймұхамедова Айжан Маликқызы **- негізгі автор,** Іскерлік әкімшіліктің докторы; Гази университеті профессоры; 06560 Йенимахалле, Силахтар көш., 17, Анкара қ., Түркия; e-mail: gulzada48@mail.ru; https://orcid.org/0000–0002–2358–0007

Аймурзинов Мұрат Сапаржанұлы; экономика ғылымдарының кандидаты; «Экономика» кафедрасының доценті; З.Алдамжар атындағы Қостанай әлеуметтік-техникалық университеті; 110000 Қобыланды батыр даңғ., 27; Қостанай қ., Қазақстан; e-mail: ams-66@mail.ru; https://orcid.org/0000–0003–1287–8913

Баймұхамедова Гүлзада Сейдувалиқызы; экономика ғылымдарының кандидаты; «Экономика» кафедрасының доценті; З.Алдамжар атындағы Қостанай әлеуметтік-техникалық университеті; 110000 Қобыланды батыр даңғ., 27; Қостанай қ., Қазақстан; e-mail: djanin65@gmail.com; https://orcid.org/0000–0002–3689–4224

Информация об авторах:

Баймухамедова Айжан Маликовна – **основной автор**; доктор бизнес-администрирования; профессор Гази университета; 06560 Енимахалле, ул. Силахтар, 17, г.Анкара, Турция; e-mail: gulzada48@mail.ru; https://orcid.org/0000–0002–2358–0007

Аймурзинов Мурат Сапаржанович; кандидат экономических наук; доцент кафедры «Экономика»; Костанайский социально-технический университет им. З.Алдамжар 110000 пр. Кобыланды батыра, 27, г. Костанай, Казахстан; e-mail: ams-66@mail.ru; https://orcid.org/0000–0003–1287–8913

Баймухамедова Гульзада Сейдувалиевна; кандидат экономических наук; доцент кафедры «Экономика»; Костанайский социально-технический университет им. З.Алдамжар; 110000 пр. Кобыланды батыра, 27, г. Костанай, Казахстан; e-mail: djanin65@gmail.com; https://orcid.org/0000–0002–3689–4224