

## ЭКОНОМИКАЛЫҚ ҒЫЛЫМДАР

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**S.V. Bepalyu**

Innovative University of Eurasia, Republic of Kazakhstan  
(e-mail: sergeybesp@mail.ru)

### **Industry 4.0: Challenges and Opportunities for the Labor Market**

#### **Annotation**

*Main problem:* In the 18th century, when industrial production began, the use of steam and mechanized production caused major changes in the economy. As a result, production costs decreased along with an increase in the quantity and quality of products. During this period, production underwent a revolutionary transition from manual labor to mechanization. The potential impact of Industry 4.0 on labor markets remains an under-explored scientific field. It is estimated that Industry 4.0 will lead to unemployment by changing the employment structure and will bring new structural problems in terms of unemployment and labor relations.

*Purpose:* The purpose of the study was to establish the impact of Industry 4.0 on the labor market and identify the consequences of the impact.

*Methods:* studied, the evolution of production development, when mass production with electricity led to the Age of Industry 2.0, and then the emergence of the digital revolution, the use of electronics and information technology in production processes, marked the beginning of the Age of Industry 3.0. It is expected, according to international experts, scientists, that automation and robotic production will have a serious impact on the unskilled workforce and cause a critical reduction in the labor force of vulnerable sectors of society, that is, women, migrants, youth and the elderly.

*Results and their significance:* This study assessed the possible impact of the fourth industrial revolution on labor markets. Through a literature review and analysis of emerging trends in Industry 4.0, the risks, opportunities and challenges of the process are explored in a comparative perspective. It has been established that countries must correctly perceive the transformation of labor markets and take appropriate measures. Otherwise, the applied labor-based low-cost industrialization model will lose its comparative advantage.

*Key words:* Industry 4.0, labor market, entrepreneurship, employment, unemployment.

#### **Introduction**

Industry 4.0 as a whole represents applications for the use of robots in industry and manufacturing, manufacturing with 3D printers, the development of artificial intelligence and big data research. These changes, also known as the Internet of Things, the Internet of Everything, or the Industrial Internet, are characterized by four distinct features from previous industrial revolutions: cyber-physical systems, big data and digital information exchange, smart robots, and digital industrialization. Accordingly, smart factories, factories automatically adapt production conditions to current conditions and organize production plans according to order requirements. Robotic technologies promise to increase the impact of the Fourth Industrial Revolution, in this regard, artificial intelligence, which is key to this transformation, is the ability of a computer or computer-controlled machine to perform various actions, analyzing the methods and techniques of human thinking.

The difference between the Industry 4.0 revolution, which will bring many changes from industrial relations to social relations, from cultural structures to political movements, is that it promises to evolve into a coordinated structure, causing the development of technology, scientific progress. In this context, with the advent of Industry 4.0, there will be a transformation in employment patterns. It is expected that some professions will appear, while some others will start to disappear and be significantly reduced.

#### **Materials and methods**

The study focuses on the fourth industrial revolution Industry 4.0 and its impact on the labor market and employment. The impact of Industry 4.0 on employment and the labor market was studied through comparative analysis and synthesis. The logical method was used to identify the characteristics and qualities of processes and phenomena that influence and have an impact on the labor market and new professions that emerge as a result. The synthetic method and statistical analysis were used to quantify the current state of the labor market and the stages of implementation of Industry 4.0.

#### **Results**

Industry 4.0 usually consists of the following 3 structures: the Internet of Things; Internet services; cyber-physical systems. The fourth industrial revolution is not only about intelligent and interconnected machines and systems; its scope is much wider. With Industry 4.0, a new manufacturing model will emerge in

which automation systems, data exchange, 3D printers and robots will be effectively used in an environment of smart factories.

Industry 4.0 is a process that brings with it challenges and opportunities. New products and services that improve the efficiency of personal life, reduce transport and communication costs, simplify logistics and global supply chains are some of these opportunities.

Industry 4.0 forces labor markets and production methods to transform, classical production methods and production relations cannot resist this transformation. Along with Industry 4.0, changes and transformations in the way goods and services are produced are expected to bring about changes primarily in industrial relations and ultimately in socio-economic and cultural structures.

It is assumed that the efficiency of production systems will be ensured by saving resources. In addition, these savings are expected to be sustainable and productivity will rise while costs decline. Production systems are being transformed into more complex structures every day. Thus, with the transition to automation / control systems, there is a decrease in the number of active personnel and an increase in the level of education of personnel [1].

There are plans to simplify data processing with supercomputers and intelligent systems, and even develop computers that will have the computing power of the human brain in about a decade. In the process of creating value, the use of 3D printer systems in the manufacturing process will reduce production processes. As the value chain grows, customer satisfaction will be maximized and the Industrial Internet will enable new business models to emerge.

Due to the introduction of new technologies, employment in the world will grow every year in the following areas:

- big data – 2.95 %;
- mobile Internet and cloud technologies – 2.47 %;
- Internet of Things – 2.27 %;
- production automation – 0.36 %.

In Kazakhstan today, if these goals are not met, any delays will increase social spending. In Kazakhstan, within the framework of Industry 4.0, the priority is the creation of new technological infrastructures and expert personnel who can work with these infrastructures. To be able to compete in global markets, it is vital to take advantage of this new industrial era, because non-innovative organizations will be removed from the market in the short term.

The growing Industry 4.0 revolution depends on organizations completing their digital transformation. For businesses that have not embraced this transformation in both the infrastructural and organizational cultural contexts, it is impossible to grasp the new era.

Industry 4.0 is a revolution in which jobs that require unskilled labor are performed by robots and skilled value-added labor specializes in creating greater productivity. In this regard, Industry 4.0 has a profound impact on both job qualifications and employee personality and the relationship between employee and employer.

Although digital transformation primarily manifests itself in the mechanization of production, it also affects social life, human systems and demographic structure. In addition, gaining communication and obtaining the highest efficiency in production systems where human-machine interaction is intensively carried out will necessarily lead to social change.

Many global companies are researching and developing the application capabilities of the Internet of Objects in order to provide a global competitive advantage. At the end of the development of the Internet of Things, not only objects, but also the participation of people in this large network will be of great benefit. Thus, the concept of the Internet of Things is expected to evolve as the Internet of All Things in the future.

When we think that technological and innovative products that we could not have imagined many years ago are now present in every moment of our daily life, we can better understand what innovations Industry 4.0 can bring in the coming years.

Another very important reason for the emergence and implementation of Industry 4.0 is the change in consumer demand. In the modern world, consumers have begun to feel the need to quickly launch new products due to the globalization of the world, as well as the increase in the number and variety of products produced. In addition, the need to meet individual customer needs is considered one of the driving forces behind the latest industrial revolution.

In addition, personalized manufacturers are also needed in order to produce customized products tailored to meet the requirements of clients in Industry 4.0.

With Industry 4.0, more and better products can be produced at lower costs and can be delivered to consumers faster using new transportation technologies such as drones and unmanned vehicles from robotics and automation-based enterprises [2].

Industry and Industrial Relations: The Impact of Technological Advances on Employment and Labor. Industry 4.0 is a transformation based on minimizing costs and increasing production line productivity. The fact that traditional milling is being replaced by intelligent technology gives the impression that the structural characteristics of the labor market are about to change.

Industry 4.0 creates the Factories of the Future, where production lines have to be connected to each other via sensor systems, data is exchanged instantly, so that software and algorithms throughout the system can be converted into instant reports. The business world must quickly adapt to a new way of manufacturing and doing business. Business can no longer remain outside the electronic information networks linking institutions and organizations. Smart factories and the Internet of Things will operate with a remote control approach, where a person participates, at least via the Internet, and in which high efficiency will be ensured. This directly affects the critical position of the labor force, which is the productive force in the modern production model, and transforms labor relations far from the classical formula of industrial relations.

We can identify four of the most important elements that differentiate Industry 4.0 from other industrial revolutions as sensors, data, information and operations. By combining these four types, unskilled labor is eliminated. With the acquisition of robots and machines that will replace unskilled labor and the nature, skill of the labor force, as well as the number of workers in the industry that will change dramatically.

The mechanization of production processes will inevitably pull the working class out of the labor market and, consequently, increase the army of the unemployed.

As can be seen from the second and third industrial revolutions, in every industrial revolution there is a need for the exchange and transformation of skills. Today we are facing a similar situation in Industry 4.0.

The fourth industrial revolution is based on premises based on information and communication technologies. Educating young people on these foundations and providing the necessary skilled workforce, starting with primary education, vocational secondary schools and universities, as well as teaching coding, software, robotics, will ensure the evolution of the workplace.

In this sense, with the new industrial revolution, some professions will come to an end, and new and high-profile professions will appear, requiring high knowledge and technology. On the one hand, while unemployment is expected to rise, on the other hand, employment will increase in the new jobs and professions that will emerge. In this new era, it is expected that the first countries to develop and use technology will reduce unemployment, and those that fail will increase the share of the unemployed population.

Research by Future of Jobs says that by 2020, “the global labor market will have 2 million jobs, but 7.1 million will not. Jobs will appear in the intellectual and high-tech sectors, while in the real sector of the economy they will be reduced. The report says that “by 2020, the number of jobs in mathematics and computer science will increase by 4.6 %, in management – by 1.4 %, in the financial sector – by 1.4 %, in sales – by 1.3 % per year, but according to the same data, the number of office jobs will be reduced by 6.1 % per year. At the same time, the Internet of Things sector will see an increase in employment in computer specialties by 4.5 % per year, and in design and engineering specialists – by 3.6 %. These changes will also affect the reduction in maintenance, repair and installation of equipment by 8 % per year, and office workers by 6.2 %.

New manufacturing technologies and 3D printing and robotics, as well as the development of automatic transport will have a strong impact on employment in various industries [3].

Employment will rise where big data analysis and management of complex technological processes are required, and will decline where there is a large proportion of routine, unskilled labor.

Since the First Industrial Revolution, the need for a more skilled workforce has always increased at different times. In the fourth industrial revolution, it is inevitable that some professions end and some change. The professions that will be in demand include technical professions, information technology specialists, internal audit expertise, digital human resources expertise, digital marketing expertise, interface design, data analytics, big data management, etc. When we look at the historical process, we see that every innovation and change leads to the emergence of new professions, at the same time leading to the loss or loss of some professions.

For example, professions such as copper working, tinning, blacksmithing, saddle making, stone carving, wooden spoon handling, basket weaving, and pottery stand out as lost professions. Likewise, in less than two decades, we will witness today's most popular professions such as SEO Specialist, 3D Printer Engineer, Data Security Engineer, Machine Learning Engineer, IT / IoT Solution Architecture, cloud computing specialist, technology design and data security expert will be missing or unknown.

It is expected that in many areas the characteristics of the workforce will change, many professions will disappear, new professions will appear, in other words, the workplace will evolve. At this stage, it is important to ensure that the process is followed and the opportunities and threats are correctly identified. While these issues are no different from the 18th century, they will certainly be different in terms of what the experience will be. The fourth industrial revolution has many opportunities and threats.

This process will have a serious impact on labor relations, and therefore on the social, economic and legal structure. The Fourth Industrial Revolution will bring new professions, new job descriptions, new industries, new initiatives, and new business opportunities.

One of the most important employment concerns is the fear that robots could replace humans in the future and that unemployment could rise. However, instead of saying that manufacturing robots will lead to unemployment, the workforce must adapt to the needs of the new era and realize its potential in areas such as robotics and automation on the one hand, and in areas such as social sciences, anthropology, service sector, natural life, organic products, education, agriculture, livestock and technology business.

New professions, new products, new processes, new production methods and new technologies must be produced by people. The transformation of the manufacturing process into a digitalization process does not mean

that it will negatively affect all employment. On the contrary, people must respond to this process with more than one transformation strategy and innovative change.

In cases where digitalization and advanced technologies are presented as beneficial by employers or governments, we must ask how workers and society will benefit from their implementation. Jochen Schroth of IG Metall offers the following table, Table 1, for benefit analysis, which can be very helpful [4].

The two columns on the left and right represent the benefits for people versus benefits for machines. If the changes do not correspond to the principles stated in the left column, we must reject them.

Table 1 – Potential benefits of digitalization for workers and society as a whole

| Actions                       | People use the system   | The system uses people  |
|-------------------------------|---|---|
| Work management               | Improving work qualifications, high influence of employees on goals and planning of work and tasks    | Decrease in qualification requirements at workplaces; narrowly set tasks with a high level of standardization |
| Work organization             | Collaboration, participation and multifaceted interaction between groups of employees                 | High responsibility / limited freedom of action   |
| Technology                    | For example, time consuming and unattractive tasks are performed by light robots.                     | The goal is complete automation; the number of employees is minimal   |
| Qualifications / Competencies | Comprehensive education and training (on and off the job), better opportunities for promotion at work | On-the-job training only  |
| Data                          | Access to information and knowledge to solve problems; protection of personal information             | Using personal data to monitor behavior and increase productivity   |

In terms of technology trends, companies can be expected in the future to turn to human-machine collaboration, simplified applications, and lightweight robots. To this can be added two-armed robots, mobile solutions, and the integration of robots into existing environments. There will be an increasing focus on modular robots and marketable robotic systems at attractive prices. Consumer demand for industrial robots is also driven by various factors. This includes addressing new materials, energy efficiency, more advanced automation concepts, and linking the real factory and the virtual world as defined by Industry 4.0 and the Industrial Internet of Business.

With the widespread use of robots in many sectors, especially manufacturing and industry, the impact on the labor force is defined in the literature as “technological unemployment”.

In accordance with the requirements of Industry 4.0, robots in factories become active members of collectives and work teams, and do not defend the only goal – to help people. For this, it is very important that humans and robots work together in the most active way.

In terms of future professions, employment agencies and organizations, especially government agencies such as employment centers, work to develop vocational skills by raising their awareness. The workforce of the future will be Generation Z, and the work habits and characteristics of this generation are not well understood. Therefore, it is not known to what extent negative scenarios are proposed in real economic and social life. An important point is that Kazakhstan has significant potential for the future of the country with its young population and is doing everything possible to use it most effectively. Given the new provisions that will be introduced into the curriculum and the criteria for success in secondary and higher education are applied, it may not be difficult for the young population to achieve the desired level in Kazakhstan.

One of the consequences of globalization is that international capital is directed to countries where labor is cheap and that labor in the country of origin faces unemployment.

Due to low labor costs in labor-intensive sectors, investments directed to underdeveloped countries will return to developed countries along with Industry 4.0.

Frey and Osborne of Oxford University estimate that 47 % of current US jobs will soon be at risk of being replaced by computer technology. A similar study was carried out for Germany, which indicates that 59 % of jobs are at risk as a result of the digital revolution. For member countries of the Organization for Economic Cooperation and Development (OECD), this figure is 57 %. A deeper analysis shows that the degree of substitution of computer technology varies considerably between different work groups. Another labor market study found that more than 50 % of current jobs in Sweden could be replaced by computers and robots within the next 20 years [5].

Obviously, this process of change will not affect the labor market in the same way. At this stage, it is assumed that the labor market will be divided into segments such as low-skilled / low-paid workers and high-skilled / high-paid workers.

It can be seen that two-thirds of people in the United States believe that most of the work that humans do is done by robots, but 80 % of these people believe that their work will not be affected by this process. It is

argued that the first impact of Industry 4.0 on labor markets is primarily technological unemployment, as in other industrial revolutions.

Industry 4.0, however, will leave unemployed primarily skilled professionals and professions that have the ability to work independently with an unskilled labor force. Sooner or later, the work of many different professions, such as lawyers, financial analysts, doctors, journalists, accountants, insurers, and librarians, will be partially or fully automated before most people figure it out.

It can be foreseen that Industry 4.0 will tend to increase the supply of skilled software, coding and robotics labor in the labor market. The fact that qualifications can be realized in the short term under the Fordist model of production has had little impact on the characteristics of labor markets. In the development of Industry 4.0, the acquisition of skills in the vocational education of the workforce is an unpredictable compensation policy in the short term. In this case, short-term unemployment in the labor market may be more concentrated on unskilled workers, and the skilled labor force will not be able to respond to the increase in supply during this short-term period. This would lead the labor market, on the one hand, to increase the wages of a small number of skilled labors, and on the other hand, reduce the tendency towards wages of the unskilled labor.

According to the World Economic Forum's 2018 Global Gender Gap Report, professions that employ both men and women are at risk of automation. Unemployment will be higher as a result of automation in male-dominated sectors such as manufacturing, construction and assembly.

However, the increased capabilities of artificial intelligence and the ability to digitize tasks in the service sector are a result of automation, and this will also lead to a decrease in labor demand in such professions as call centers and the retail sector, where women traditionally occupy a higher place [6].

In other words, due to the automation of many jobs, the female workforce is expected to face the greatest job losses. It is assumed that the creation of new jobs to replace the lost ones will not be as proportional as the jobs created in previous revolutions. It is clear that the blue collars of past industrial revolutions are no longer needed, and white collars will only work in areas that cannot be filled with automation and robotics. However, the skilled workforce of gray collars and gold collars are able to work in accordance with their ability to benefit from their knowledge, skills and experience.

New technologies show their presence in the production structure at the first stage. But transformation in manufacturing can affect the direction of supply and demand in labor markets and consumer behavior in the second phase. Efficiency companies to save labor resources, ensure inventory management, ensure effective process control, apply quality management, and control sales and after-sales processes offer a wide range of opportunities in terms of efficiency.

The displacement of labor by machines can lead to lower employment levels as well as minimizing the number of failures in production. The decisive factor for human participation in production is the factor of ability. This can exacerbate low skill levels / low wages, high skill levels / high wage gaps.

According to the World Economic Forum's Future of Jobs report, 65% of the future occupations of primary school students will be in as-yet-unknown occupations, and these occupations will require high levels of creativity, problem solving, logical and mathematical thinking, and visual ability.

In addition, the same report predicts that data analysts will be more in demand in all sectors in the future. Programmers, software developers, and information security analysts will rank second in computing and mathematics. In second place are architecture and engineering, sales specialists, top managers, product designers, HR and organizational development specialists, and government relations specialists. Almost every sector, every area of business will be digitized, as already mentioned, and each will become a separate line of business [7].

The increased demand for expert technical skills can exacerbate gender inequalities and the gap between male and female roles, as males retain their weight in computer science, mathematics, and engineering. However, the demand for roles based on human characteristics and abilities, such as empathy and sensitivity, may grow, and machines cannot fill them. Women are overwhelmingly in occupations such as psychologists, therapists, trainers, activity planners, physiotherapists, nurses and other medical professions.

Industry 4.0 and its infrastructure are transforming developed economies, and this will fully affect the global economy. For example, automation work will return to the EU and the US. By 2025, there will be 30 billion smart objects in use around the world, and 47 percent of today's enterprises will be able to automate their operations. In 2025, 30 % of US imports from China are planned to be made in the United States.

Industrial production 4.0 for the first time reminded of robotic technologies and employment problems in Kazakhstan.

Manufacturing workers in the fourth industrial revolution will not lose much of their jobs, but their job descriptions and professions will change. Today blue collars will be turned into knowledge workers. The next generation will be eligible for a new period starting in primary school, with Industry 4.0 and technology learning. Industry 4.0 will bring about changes in many areas such as industry, technology, public welfare, technical infrastructure, education, production and consumption.

The Fourth Industrial Revolution is expected to facilitate high-tech manufacturing and service operations.

New technologies may have some disadvantages as well as advantages. At the beginning of this period, human health will be protected in some sectors that are very dangerous and harmful to human health (chemical industry, dyes, yarns, mines and construction) by using robots instead of workers.

Nowadays, humans and machines work hand in hand along with human-robot collaboration in many new applications.

Industry 4.0 innovations are not just about professions. The employee and employer will also change their relationship. Tasks and projects that are distributed across human cloud platforms are performed by workers who are more independent than dependent traditional employees. Some employees will be able to work as semi-independent like UBER driver, Instacart shopper, Airbnb renter or Taskrabbit installer. In this process, they will not be subject to such obligations as the minimum wage, employment tax and social security for those who are self-employed [8].

Another area that will have a huge impact on industry change will be trade unions. The strength of workers' unions against employers will diminish with the replacement of robots in factories instead of labor and the spread of free work with human-cloud platforms.

The expected changes in working life can be summarized as follows:

- the need for unskilled labor will be reduced;
- the need for skilled workforce and digital skills will grow;
- instead of the lost professions, new professions and jobs will be created, many new jobs will appear;
- the importance of flexible structures that can quickly respond to changes in working conditions will increase;
- there will be a transformation in the social structure;
- occupational health and safety will be supported by robots and more stringent measures can be taken against these risks;
- in the face of cybersecurity risks, the concepts of vocational education and training throughout life will gain more and more importance;
- trade unions will lose their importance and strength;
- working hours will be reduced by improving working conditions and balance between work and personal life;
- freelancers will increase due to human-cloud platforms;
- the wages of unskilled workers will fall;
- the wages of skilled workers will rise.

It is believed that highly hazardous work will be performed by robots, and human losses will be reduced due to industrial accidents.

In terms of business relationships, Industry 4.0 will bring about major changes. However, these disruptions will occur not only in countries that have completed their industrial infrastructure, but also in developing and industrializing countries. In fact, Industry 4.0 is expected to have a greater impact on developing countries.

Since developing countries that have not yet completed their industrialization cannot transform the education system into the preparation of a high-quality workforce, they cannot quickly create and transform their economies towards the production of products with high added value. The common characteristics of such underdeveloped countries are low labor costs and low production costs due to an inadequate and unskilled labor force and a lack of legislative infrastructure.

Less developed or developing countries will face waves of mass unemployment as Industry 4.0 increasingly transforms manufacturing and as global employment begins to shift back into the industrialized world. Therefore, in order to compete with industrialized countries, increasing their ability to produce high quality, affordable and personalized products will be an important challenge for developing countries.

According to forecasts of the Ministry of National Economy of the Republic of Kazakhstan, by 2022 the number of people employed in the economy will grow to 8.6 million people, of which 33% will be employed in the real sector, and 67 % in the service sector.

The greatest decrease in demand is expected in the agricultural sector, where the release of workers will amount to 240 thousand people. And the biggest growth is in the “social economy”. Sectors such as education, health care and public administration will provide an increase in employment of 121.5 thousand people.

The most favorable conditions for employment growth are developing in the regions that determine the dynamics of secondary modernization and the service sector in Kazakhstan. The axis of business activity will remain Almaty-Karaganda-Nur-Sultan. In these regions, the main intra-republican migration flow is formed.

Until 2022, the national economy will need about 459.0 thousand workers. Due to the change in the structure of demand for labor, it is expected to reduce about 288.4 thousand jobs. According to estimates, the number of potentially unemployed and workers requiring retraining will be 208.1 thousand people by 2022.

### **Discussion**

According to the forecasts of the Ministry of Labor and Social Protection of the Population of the Republic of Kazakhstan, by 2022 in the country as a whole, the most demanded professions will be workers providing individual services, architects and engineers, employees of services for the protection of citizens and property, middle administrative and managerial personnel, health professionals.

The least in demand will be unskilled agricultural workers, crop and livestock producers, tent and market sellers. As a result of technological transformations, new professions will appear and old ones will disappear or partially change. An assessment of the impact of modernization on the release of labor in Kazakhstan shows that today already 16% of enterprises (out of 10 thousand surveyed enterprises) are planning technological re-equipment, automation of production processes, labor mechanization, digitalization or other modernization. This eliminates the need for mid-skilled and low-skilled personnel, while there is a boom in demand for highly qualified employees [9].

In Kazakhstan, in the structure of employment by level of qualifications, an increase in the share of workers with high and medium qualifications is expected (+459 thousand), while the share of workers with low qualifications will significantly decrease (-288.4 thousand). According to the forecast, by 2022, the economy will employ about 1.5 million people with low qualifications, 5.0 million people with an average level and about 2.0 million people with a high level of qualifications.

The modernization of the economy will require specialists in the field of the latest technologies, informatics, biotechnology, and alternative energy. In the future, the imbalance between the quality of jobs and the professional and qualification composition of the labor force will inevitably increase if appropriate measures are not taken to regulate these processes.

In the future, a number of professional specializations in the field of science can be attributed to the number of diminishing or disappearing professions, which is caused by the aging of the personnel. The replacement process will affect a number of professions with standardized functions in industries, primarily in the mining and metallurgical sector (miners, drifters, drillers, blastmen, foundry workers, furnace operators, etc.).

At the same time, the cost of labor will slow down the disappearance of professions and the replacement of people with machines. Technological renewal requires large investments, while in the short term, job retention can lead to cost savings for enterprises. However, without the necessary qualifications of workers, the productivity of enterprises will remain at a low level.

### **Conclusions**

During the study, it was revealed:

1. Investigation of the likely impact of Industry 4.0 on Kazakhstan in different dimensions is essential.
2. As in many other areas, Industry 4.0 has opened the door to radical social and economic changes. It is inevitable that in Kazakhstan, the Industry 4.0 revolution will bring many changes from industrial relations to social relations and transformations.
3. In Kazakhstan, Industry 4.0 will bring about a critical transformation in labor relations. The processes of industrial transformation have not yet been completed, and the education system is only being transformed to prepare a high-quality workforce, which will subsequently create an economic system based on products with high added value.

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**С.В. Беспалый**

Инновациялық Еуразия университеті, Қазақстан Республикасы

### **Индустрия 4.0: еңбек нарығындағы қиындықтар мен мүмкіндіктер**

XVIII ғ. басталған өнеркәсіптік өндірісте бу мен механикаландырылған өндірісті пайдалану экономикада үлкен өзгерістер тудырды. Нәтижесінде өнімнің саны мен сапасының артуымен бірге өндіріс шығындары төмендеді. Осы кезеңде өндіріс қол еңбегінен механикаландыруға революциялық жолмен өтті. Индустрия 4.0-дің еңбек нарығына әлеуетті әсері әлі зерттелмеген ғылыми сала болып қала береді. Индустрия 4.0 жұмыспен қамту құрылымын өзгерту арқылы жұмыссыздыққа әкеледі және жұмыссыздық пен еңбек қатынастары тұрғысынан жаңа құрылымдық мәселелер тудырады деп есептеледі.

Зерттеудің мақсаты: Индустрия 4.0-дің еңбек нарығына әсерін және әсердің салдарын анықтау болып табылады.

Өндірістің даму эволюциясы зерттелді, электр энергиясымен жаппай өндіріс «Индустрия 2.0» дәуіріне алып келді, содан кейін цифрлық революция пайда болды, «Индустрия 3.0» өндіріс процестерінде электроника мен ақпараттық технологияны қолдану басталды. Халықаралық сарапшылардың, ғалымдардың пікірі бойынша автоматтандыру және роботтандырылған өндіріс біліксіз жұмыс күшіне үлкен әсер етеді және қоғамның осал секторларының, яғни әйелдер, мигранттар, жастар мен жұмыс күшінің қысқаруына алып келеді деп күтілуде.

Бұл зерттеу төртінші өнеркәсіптік революцияның еңбек нарығына мүмкін әсерін бағалады. Индустрия 4.0-де қалыптасып келе жатқан тенденцияларға әдеби шолу және талдау жасау арқылы процестің тәуекелдері, мүмкіндіктері мен қиындықтары салыстырмалы түрде қарастырылады. Елдерде еңбек нарығының өзгеруін дұрыс қабылдау және тиісті шаралар қойылуы керек екендігі анықталды. Әйтпесе, қолданылатын еңбекке негізделген арзан индустрияландыру моделі салыстырмалы артықшылығын жоғалтады.

Түйін сөздер: Индустрия 4.0, еңбек нарығы, кәсіпкерлік, жұмыспен қамту, жұмыссыздық.

**С.В. Беспалый**

Инновационный Евразийский университет, Республика Казахстан

### **Индустрия 4.0: вызовы и возможности для рынка труда**

В 18 веке, когда началось промышленное производство, использование пара и механизированного производства вызвало серьезные изменения в экономике. В результате этого производственные затраты снизились вместе с увеличением количества и качества продукции. В этот период производство претерпело революционный переход от ручного труда к механическому. Потенциальное влияние Индустрии 4.0 на рынки труда по-прежнему остается малоизученной научной областью. По оценкам, Индустрия 4.0 приведет к безработице за счет изменения структуры занятости и принесет новые структурные проблемы с точки зрения безработицы и трудовых отношений.

Целью проведенного исследования является определение влияния Индустрия 4.0 на рынок труда и выявление последствий этого влияния.

Автором изучена эволюция развития производства, когда массовое производство с помощью электричества привело к Эре Индустрии 2.0, а затем появление цифровой революции, использование электроники и информационных технологий в производственных процессах положило начало Эре Индустрии 3.0. Ожидается, по мнению международных экспертов и ученых, что автоматизация и робототехническое производство окажут серьезное влияние на неквалифицированную рабочую силу и вызовут критическое сокращение рабочей силы уязвимых слоев общества, то есть женщин, мигрантов, молодежи и пожилых людей.



В этом исследовании оценивалось возможное влияние четвертой промышленной революции на рынки труда. Благодаря обзору литературы и анализу возникающих тенденций, связанных с Индустрией 4.0, риски, возможности и проблемы процесса исследуются в сравнительной перспективе. Установлено, что страны должны правильно воспринимать трансформацию рынков труда и принимать соответствующие меры. В противном случае применяемая низко затратная модель индустриализации, основанная на рабочей силе, потеряет свое сравнительное преимущество.

Ключевые слова: Индустрией 4.0, рынок труда, предпринимательство, занятость; безработица.

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