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Evaluatıon of Technologıcal Development Indıcators ın Kazakhstan Under Industry 4.0

Abstract. *The understanding of the fourth industrial revolution is important in determining the direction in Kazakhstan according to the fourth industrial revolution. On the way to the list of 50 developed countries, it is important to assess the level of readiness of Kazakhstan in terms of technological infrastructure for Industry 4.0. This article covers the effects of the process of Industry 4.0, the so-called smart manufacturing, which constitutes the fourth generation of the industrial revolution, and the factors influencing this process. In addition, in this study, the types of technological products that can be evaluated in the framework of Industry 4.0 for the economy of Kazakhstan and the created economic value are studied. In this context, the impact of scientific research and education on technological changes and transformation was studied as the most important direction. Thus, it is possible to draw a conclusion about the development process of the Industry 4.0 period of Kazakhstan.*

In order to fundamentally change the economy of our country, it is intended to create competitive industries, and it is possible to achieve a competitive economy by introducing technologies and science into production.

Keywords: *Industry 4.0, technological development, innovation, R&D activities, technological products, factors, technological infrastructure.*

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Introduction

The concept of "Industry 4.0", which came to the agenda for the first time at the Hannover Fair held in Germany in 2011, is a production technique that uses smart technologies and techniques, which are the growth trend of the 21st century, at every stage of production, thus abandoning the centralized production structure and enabling the transition to flexible production. It emerges as a new phenomenon that includes concepts such as cloud technology, internet of things, artificial reality, big data, and digital economy. The reason for the birth of Industry 4.0, supported by the German government, is that China has taken over global markets by expanding its production network and the trade networks of European countries are adversely affected [1]. This situation has revealed the need for developing new technologies for Germany and the Industry 4.0 process has been initiated. Industry 4.0 is based on the use of cyber-physical systems that create smart factories [2]. Industry 4.0 is a collective set of technologies and concepts of value chain organizations. Industry 4.0 features are listed below [3]:

- It cannot happen without informatics infrastructure;
- Smart production will take place with the information infrastructure;
- The process will be strengthened with the legal infrastructure;
- It will continue to develop with new business models.

The purpose of this study is to draw attention to the measures to be taken in line with the analysis of the quality of R&D expenditures made in Kazakhstan in the fourth industrial revolution that came to the agenda. Considering the innovation activities carried out so far, understanding the fourth industrial revolution is important in determining the direction of the fourth industrial revolution in Kazakhstan. It is important to evaluate the level of preparation of Kazakhstan in terms of technological infrastructure for Industry 4.0 in the list of developed 50 countries.

In the context of the new reality and the hindrances of adapting to remote operation, Industry 4.0 allows enterprises to be prepared for the so-called "Black Swans", in this case refers to the coronavirus pandemic. To date, the implementation of Industry 4.0 is already well advanced, and no country can stay away from it. Government programs to increase the competitiveness of industries using Industry 4.0 technologies have been adopted in many countries: in Germany, China, Mexico, Italy, Latvia, Russia, etc. The transition to the concept of Industry 4.0 in the countries is due to the possibility of increasing the competitiveness of enterprises by optimizing production costs, the emergence of new sources of income, the emergence of new niches, improving working conditions, reducing accidents and injuries at work. Herewith, COVID-19 acted as a trigger for the introduction of Industry 4.0 technologies not only in countries where government programs have been adopted, but also in countries where there is no uniform policy for the development of Industry 4.0. In a pandemic, Industry 4.0 is an effective way to adapt to rapidly changing conditions and, as a result, a tool for survival in competition. Those companies and, accordingly, countries that are the slowest to implement digital technologies in the context of a pandemic will suffer the most. There will be a risk of lagging behind in technological development and the inability to integrate into global value chains, which will eventually lead to a loss of competitiveness. Is Industry 4.0 in Kazakhstan ready for a prolonged pandemic? For the time being, majority of industrial enterprises are continuing projects on implementing of Industry 4.0 technologies. As a rule, these projects were approved in the previous period, and what is planned for 2020 will be executed. It is possible that there will be an adjustment for the projects for 2022-2025. The pandemic has only accelerated the introduction of Industry 4.0 technologies that provide remote communication and allow organizing processes in production with minimal human participation. In general, much will depend on which industries are developed to one degree or another. Industries that are characterized by a large proportion of non-digitized production processes will be most affected. Regarding the benefits from the introduction of Industry 4.0 technologies, these technologies made it possible to reorient production to remote mode in a short period and even deploy new production such as: protective screens and spare parts for ventilators (artificial lung ventilation). In addition, technologies such as big data analysis, sensors and telematics make it possible to carry out operational work as quickly and efficiently as possible and to react in a timely manner and make adjustments to production processes by remote access.

Literature Review. Progressive globalisation, mass customisation and competitive business environments mean that ‘traditional’ enterprise is facing new business challenges in today’s turbulent economy. (Simmert et al. 2019)

Industry 4.0 technologies may be grouped into physical and digital technologies. Physical technologies mainly refer to manufacturing technologies such as additive manufacturing (Dalenogare L.S. et al.), or sensors and drones (Frank A.G., et al., 2019). Digital technologies mainly refer to modern information and communication technologies, such as cloud

computing, blockchain, big data analytics, and simulation (Zheng T. et al., 2021).

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The demand for faster delivery times, more efficient and automated processes, higher quality and customised products are driving companies towards the so-called fourth industrial revolution, known as Industry I4.

The previous three Industrial revolutions led to great increases in productivity driven by mechanisation, electricity and information technology (Dalmarco G. et al.,2019). For Industry 4.0, the underlying technology is represented by Cyber-Physical Systems (CPS), which make production systems modular and changeable, thus able to mass produce highly customised products (Chiarello F. et al., 2018). Indeed, when CPS communicate over the Internet of Things, they connect infrastructure, physical objectives, human actors, machines and processes across organisational boundaries, enabling the fusion between physical and virtual world, exploiting sensors, actuators, and computation power to transmit data in real-time for decentralised decision-making processes Kumar et al. 2020). Meanwhile, there are other digital technologies that have emerged as enablers of Industry 4.0. Tahmasebinia, F., Sepasgozar S.M., Shirowzhan S., Niemela M., Tripp A., Nagabhyrava S., & Alonso-Marroquin, F. (2020) investigate profit maximisation in 3D.

One terms today is «big data». Big data is a term used to describe a set of data that goes beyond the storage, management, and processing capabilities of widely used applications. The combination of large amounts of data and the complexity of analysis required to obtain benefits from the data has led to the development of new types of technologies and tools to manage them. (Azretbergenova, G. Z., & Syzdykova, A. O. 2020).

Kazakhstan’s fintech market is at an early stage of market development. The government shows a desire to develop the market by attracting foreign investment and helps in every way to regulate the online loan market and venture financing. The government also founded the Astana International Financial Center, where there is a special zone with privileges for fintech startups. (Kobadilov &Omarov) Industry 4.0 can fulfil the requirements of customised face masks, gloves, and collect information for healthcare systems for proper controlling and treating of COVID-19 patients. Authors discussed ten major technologies of Industry 4.0 which help to solve the problems of this virus. Authors believe that the proper implementation of these technologies would help to enhance education and communication regarding public health. These Industry 4.0 technologies could provide a lot of innovative ideas and solution for fighting local and global medical emergencies. (Javaid M. et al.,2020).

Methodology

Summarizing and analytical methods were used to achieve the objectives of the study. Articles and seasonal publications related to the Fourth Industrial Revolution published abroad were discussed. In addition, official statistics were collected and an assessment of Kazakhstan's technological infrastructure was made. In this context, the level of digital literacy of the population of the Republic of Kazakhstan, R&D activities in Kazakhstan, innovation indicators and the share of innovative products in GDP in Kazakhstan were studied.

Discussion

In the context of the new reality and the hindrances of adapting to remote operation, Industry 4.0 allows enterprises to be prepared for the so-called "Black Swans", in this case refers to the coronavirus pandemic. To date, the implementation of Industry 4.0 is already well advanced, and no country can stay away from it. Government programs to increase the competitiveness of industries using Industry 4.0 technologies have been adopted in many countries: Germany, China, Mexico, Italy, Latvia, Russia, etc. The transition to the concept of

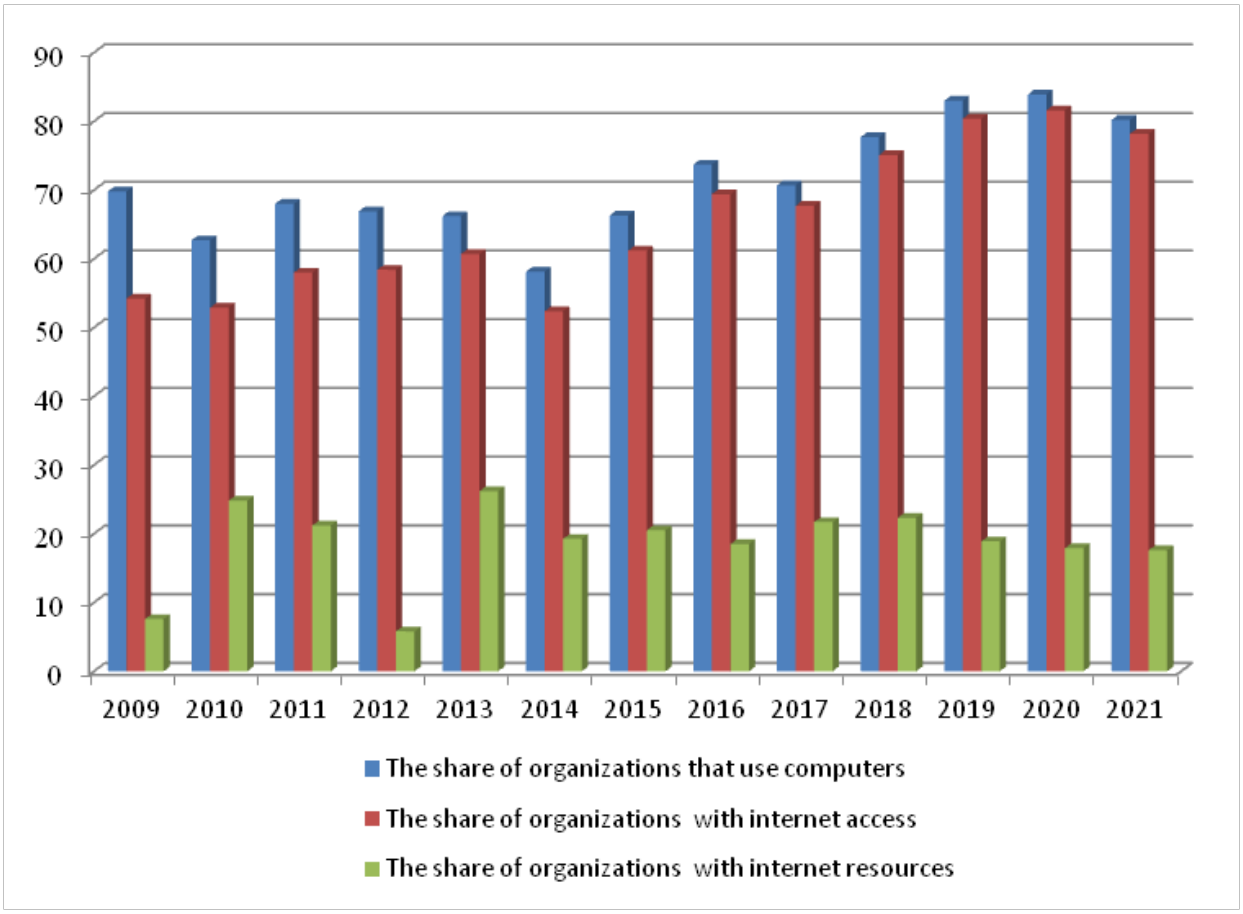

Figure 1 – Indicators of ICT use in organizations (%)
(excluding public administration organizations)

Source: Compiled by the authors of the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (https://stat.gov.kz/)

Industry 4.0 in the countries is due to the possibility of increasing the competitiveness of enterprises by optimizing production costs, the emergence of new sources of income, the emergence of new niches, improving working conditions, reducing accidents and injuries at work. Herewith, COVID-19 acted as a trigger for the introduction of Industry 4.0 technologies not only in countries where government programs have been adopted, but also in countries where there is no uniform policy for the development of Industry 4.0. In a pandemic, Industry 4.0 is an effective way to adapt to rapidly changing conditions and, as a result, a tool for survival in competition. Those companies and, accordingly, countries that are the slowest to implement digital technologies in the context of a pandemic will suffer the most. There will be a risk of lagging behind in technological development and the inability to integrate into global value chains, which will eventually lead to a loss of competitiveness. Is Industry 4.0 in Kazakhstan ready for a prolonged pandemic? For the time being, majority of industrial enterprises are continuing projects on implementing of Industry 4.0 technologies. As a rule, these projects were approved in the previous period, and what is planned for 2020 will be executed. It is possible that there will be an adjustment for the projects for 2022-2025. The pandemic has only accelerated the introduction of Industry 4.0 technologies that provide remote communication and allow organizing processes in production with minimal human participation. In general, much will depend on which industries are

developed to one degree or another. Industries that are characterized by a large proportion of non-digitized production processes will be most affected. Regarding the benefits from the introduction of Industry 4.0 technologies, these technologies made it possible to reorient production to remote mode in a short period and even deploy new production such as: protective screens and spare parts for ventilators (artificial lung ventilation). In addition, technologies such as big data analysis, sensors and telematics make it possible to carry out operational work as quickly and efficiently as possible and to react in a timely manner and make adjustments to production processes by remote access.

Evaluation of Kazakhstan's technological infrastructure. In recent years, in which the fourth industrial revolution is developing, Kazakhstan's indicators are very important regarding the availability of technology. Kazakhstan is an important bridge between Europe and Asia at the point of transfer of the revolution that is developing due to its geopolitical geography. It is important to evaluate the level of preparation of Kazakhstan in terms of technological infrastructure for Industry 4.0 in terms of entering the list of 50 developed countries. The status of communication infrastructure in Kazakhstan can be explained with the help of graphic 1 and graphic 2. When we examine the Graph 1 data, it is seen that although computer use and internet access are relatively high in enterprises, it falls far behind in website ownership [15].

When we consider that the fourth industrial revolution has brought the era of speed in communication and access, it can be thought that in order to expand the production and marketing networks over the internet, website ownership should be on the rise. However, as can be seen from the graph, it can be said that the use of the Internet is not widespread enough in this regard, and even at a very low level. Although legal arrangements have been made for the reasons for this, it can be said that internet shopping is not reliable enough for consumers. When it is taken into account that devices, robots and objects will be connected to each other with the internet, smart factories will be set up, and these factories will be managed through automation and web sites through applications.

With the widespread use of smart phones, it can be observed from Graph 2 that households' use of technology has increased. In 2009, the number of mobile subscribers per 100 people was 103 units, while in 2019 it was 143 units. We see that the figure for 2019 increased by 38% compared to 2009. Compared to the figures in this table, the highest figure in 2012 was 180. The number of registered Internet subscribers per 100 people, the number of Internet users in the country increased from 2009 to 2019 per unit. In 2008 this figure was 4 people per 100 people, in 2019 it was 13 people. The overall growth is relatively 32.5%. The number of registered broadband Internet subscribers per 100 people increased by 65% between 2009 and 2021. There is a relative growth rate from 2009 to 2013, and stability is observed between 2009 and 2020.

From 2009 to 2014, there is a steady growth rate in the provision of computers per 100 people. The highest rate here is in 2014, the total for this year was 34 units. It remained stable from 2016 to 2019. In general, in the analysis of 2009-2019, the growth rate is 55.5%.

The number of internet users aged 16-74 per 100 people has increased rapidly in recent years. Just as the total number of internet users in the world has increased recently, there has been an increase in the number of internet users in our country. This figure was 15 people in 2009, and in 2010 it doubled and amounted to 32 people. In the period from 2012 to 2015, the stable figure is 68 people. The number of customers in 2019 is 83. According to this schedule, there is an increase in the number of internet users. In general, if we compare the indicators of 2019 with 2009, there is an increase of 68 people. There was a dynamic increase in the relative indicator by 100 people.

Although this may seem like a development for Kazakhstan compared to 2009, it is not sufficient. Considering the technological and digital change that emerged with the fourth industrial revolution, households should have access to information and communication at a rate higher than 80%. Proposed for the fourth industrial revolution; All devices can be quickly connected to the internet

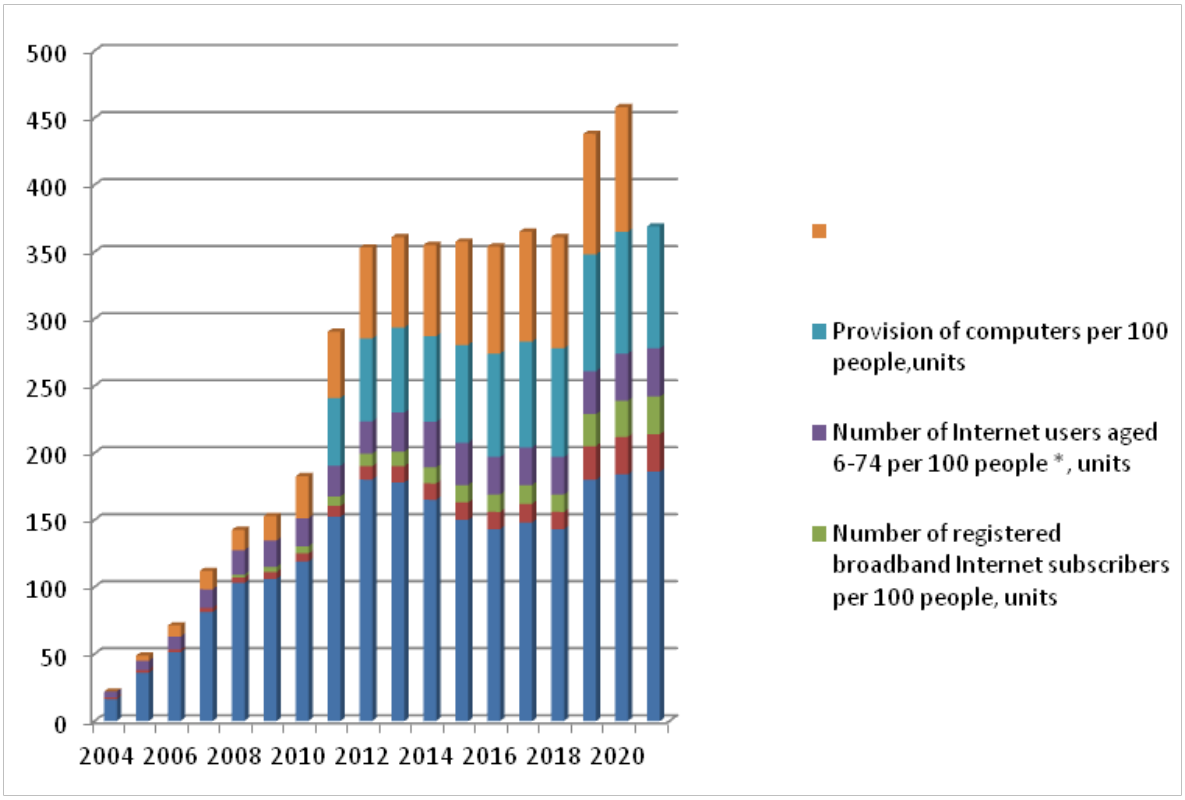

Figure2 – Indicators on the factor "Level of technological development"

Source: Compiled by the authors of the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (https://stat.gov.kz/).

and remotely controlled. In this case, it may be necessary to accelerate the infrastructure works in Kazakhstan and especially to expand the use of technology through training programs.

Table 1 shows the digital literacy level of the 6-74 age population in Kazakhstan. The use of any of the 4 types of technology mentioned in the note in 2018 amounted to 74.9%, in 2019 this figure was 73.6%. In 2019, compared to 2018, it decreased by 1.7%. In 2019, this figure has increased significantly.

According to the list of basic species (paragraphs 1, 2, 3 and 6 of the note) in 2018 it was 60.8%, in 2019 it was 68.1%. If we compare the figure for 2019 with the figure for 2017, it was 115.7% and increased by 15.7%.

Personal computer, smartphone, tablet, laptop; standard programs; the use of Internet services are showing a positive trend in Kazakhstan. The level of the Internet using and access to services by all institutions and the population has increased. Compared to 2017, the total increase in 2019 was 6.4%.

Personal computer, smartphone, tablet, laptop; the use of standard programs shows the growth rate in recent years. In 2017, the growth rate compared to 2018 was 103.9 percent, and in 2019 compared to 2017 amounted to 108.1 percent. 2020 year - Personal computer, smartphone, tablet, laptop; standard programs; Use of Internet services and services 79,3, 2021 year 87,3 percent. In 2021 compared to 2017 amounted to 113.2 percent. There is a positive trend in the use of its services via the Internet.

Although internet access in Kazakhstan seems to have a valid competence for today's technology, it can be said that future technologies are not capable of sufficient for the new internet-based technology products to be developed within the scope of the fourth industrial revolution, sufficient internet usage is not realized and technology availability is limited for Kazakhstan.

Table 1 – Level of digital literacy of the population of the Republic of Kazakhstan aged 6-74 (%)

	The share of people who have acquired skills				
	2017	2018	2019	2020	2021
Use any of the 4 types of technology listed in the Note	74,9	73,6	76,1	76,8	79,1
Use of the list of basic types (paragraphs 1, 2, 3 and 6 of the note)	60,8	68,1	70,4	79,3	84,5
Personal computer, smartphone, tablet, laptop; standard programs; Use of Internet services and services	77,1	79,6	82,1	84,1	87,3
Personal computer, smartphone, tablet, laptop; use of standard programs	79,9	83,2	81,4	83,1	85,4

Notes:
1) use of a personal computer, smartphone, tablet, laptop;
2) use of standard programs (text and spreadsheet editors, etc.);
3) use of services and services provided via the Internet;
4) resolution of issues related to the protection of computers and personal data;
5) use of software and hardware solutions in professional activities;
6) use of any digital devices (digital cameras, digital camcorders, webcams, digital televisions, DVD players, projectors, etc.).

Source: Compiled by the authors of the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (https://stat.gov.kz/).

It should be taken into consideration that today's usage areas of smart phones are only used by people within the scope of communication and social network, and their academic usability is limited to improve R&D research.

Results

R&D Activities in Kazakhstan. Examining the ratio of R&D expenditures to GDP in Kazakhstan (Figure1,2), Kazakhstan lags far behind the world average and high-income countries. The ratio of R&D expenditures to GDP in the world in 2019 was 2.31%, while in high-income countries this figure was 1.86%. On the other hand, research costs in Kazakhstan have decreased in recent years compared to the early 2000s. The ratio of research expenditures to GDP averaged 0.23% in 2000-2009, but has declined to 0.12% in recent years. R&D spending is growing worldwide, but declining in Kazakhstan.

In Kazakhstan, whose R&D expenditures are well below the world average, R&D expenditures are of great importance in achieving the integration with Industry 4.0 and achieving sustainable growth targets. It is known that the most important driving force of economic growth in Kazakhstan is the increase in capital accumulation [5]. However, as emphasized in Solow and endogenous growth models, growth; changes depending on the increase or decrease in production factors such as capital, output per worker and labor. However, the most important factor to be considered here is that a sustainable growth cannot be achieved in the long run due to the decreasing efficiency of capital.

Therefore, achieving growth in the long term requires creating innovation, which is considered exogenous, and a transition to capital-intensive, technology-oriented production. In this context, supporting technological investments, especially in the manufacturing industry, ensuring energy

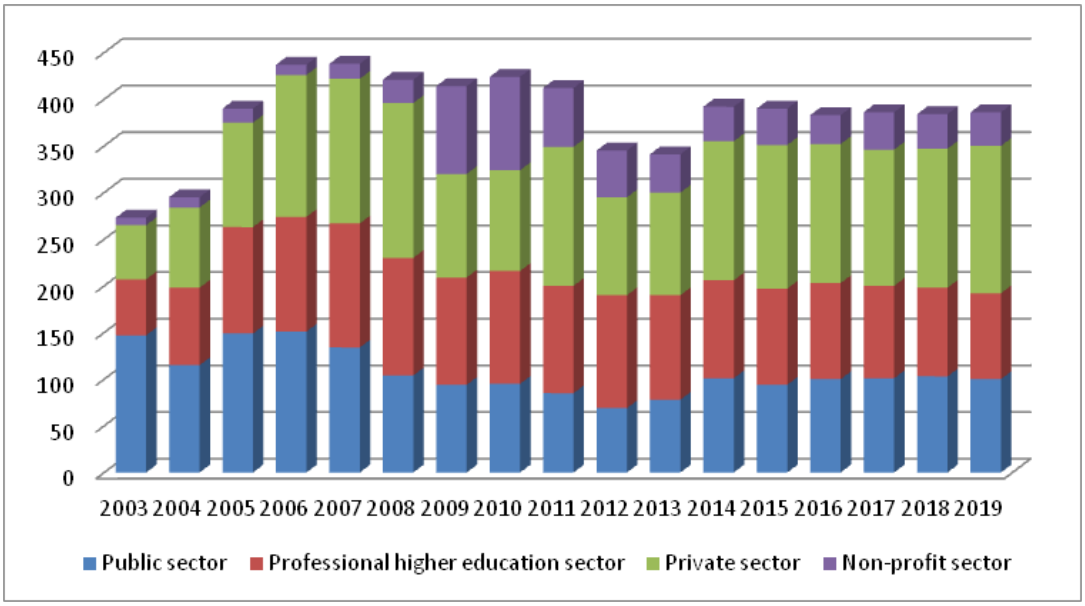

Figure 3 – Basic indicators of research and development work in the Republic of Kazakhstan

efficiency and creating added value in production will be made possible by an increase in R&D activities [16].

It is striking that there are some factors that affect the success or failure of countries in producing and exporting technologies for Industry 4.0. At this point, the first factors that come to mind are the investments of the countries to support R&D activities and their education policies. In addition to these, strategies for developing critical thinking, creativity, behavioral and social skills are supported in economies that encourage innovation. In this context, while the share of R&D expenditures in GDP in many developing countries such as Kazakhstan is quite low; It is known that a significant budget is allocated for R&D expenditures in countries such as South Korea, Japan and Finland that have taken very firm steps towards qualifying human capital. Thus, they managed to increase their export items for technology products in the long term, not in the short term. Human capital accumulation increases and innovative products with high added value are obtained in countries that implement a creative thinking-oriented STEM (Science, Technology, Engineering and Mathematics) education system where skills and innovation are emphasized in education. However, these outputs turn into economic value in the long run and affect the country's economy [17].

The sectoral distribution of R&D enterprises in Kazakhstan. In 2003, the total number of R&D organizations in the country was 273, while by 2019, this figure reached 386. In other words, the number of R&D Enterprises has increased by about 41.4% over the past 11 years. Of the 386 businesses available in 2019, 100 are in the public sector, 92 are in the higher vocational education sector, 158 are in the private sector and 36 are in the non-profit sector. In other words, most R&D enterprises in the country are privately owned. Here, in terms of creating innovation awareness, it is observed that the work done in recent years has been perceived by the private sector and given weight to R&D rapidly. Considering the total operating enterprises, it seems that public enterprises are not at a sufficient level. The innovative work of many developed states has promoted the country's economy to the top by supporting it with public spending.

Innovation indicators. Figure 3,4 shows the share of innovative products produced in Kazakhstan in GDP. According to the table, in 2019 the share of innovative products in GDP will be 1.41%. This figure is 26% lower than in 2018. However, compared to previous years, we can see an increase in the share of innovative products in GDP. However, this is a very low figure compared to developed countries in the world.

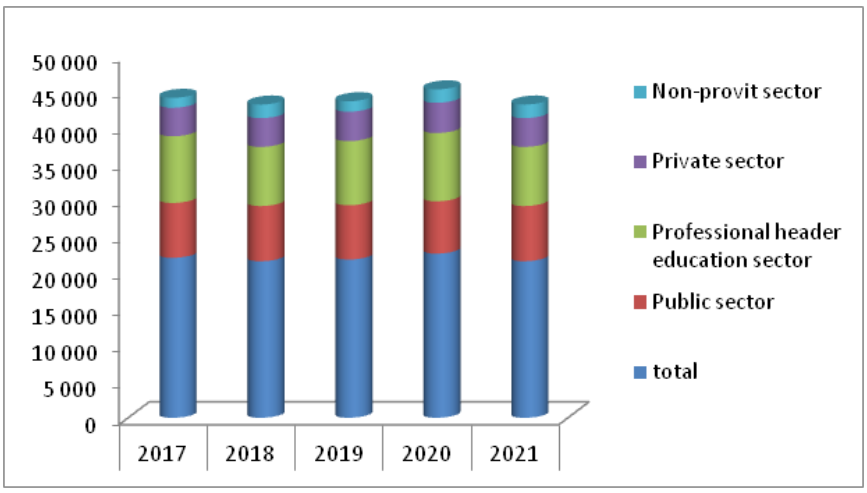

Figure4 – Index of scientific publications 2017-2021

Table 2 – The share of innovative products in GDP in Kazakhstan, (%)

	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Share of innovative products in GDP,%	1.58	0.65	0.84	1.22	1.61	1.46	0.92	0.95	1.55	1.91	1.41	2,43	2,5
Source: Data from the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (https://stat.gov.kz/).													

According to the strategic plan of the department in 2020-2024, if in 2020 the investment in information technology, innovation and scientific and technical potential amounted to 193 billion tenge, then by 2024 this figure will increase to 593 billion tenge.

In particular, in the current year it is planned to attract 254 billion tenge of investment, which is 31.6% more than last year. In 2022, this figure will grow to 335 billion tenge, and in 2023 - to 448 billion tenge.

Together with that, it is expected that the share of innovative products in GDP will reach 2.8% in 2024. In 2020, this figure was 2.5% in the previous year and will remain the previous year.

It is planned to increase the share of local content in IT services in Kazakhstan. If last year it was 65%, then by 2024 it will grow to 71%. This year it will be 67.5%.

The Global Innovation Index (GII) ranks world economies according to their innovation capabilities. Consisting of roughly 80 indicators, grouped into innovation inputs and outputs, the GII aims to capture the multi-dimensional facets of innovation.

The following table shows the rankings of Kazakhstan over the past three years, noting that data availability and changes to the GII model framework influence year-on-year comparisons of the GII rankings. The statistical confidence interval for the ranking of Kazakhstan in the GII 2021 is between ranks 77 and 83.

Table 3 – The Global Innovation Rankings for Kazakhstan

	Gll	**inputs**	**outputs**
2019	79	64	92
2020	77	60	94
2021	80	61	97
Source: Data from the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan (https://stat.gov.kz/).			

Kazakhstan performs better in innovation inputs than innovation outputs in 2021.

This year Kazakhstan ranks 61st in innovation inputs, lower than last year but higher than 2019. As for innovation outputs, Kazakhstan ranks 97st. This position is lower than both 2020 and 2019.

According to the world data on January 1, 2022, Kazakhstan United Nations Development Program: According to the Education Index 2020, the leading positions in this ranking are Germany, Norway and England. Among the countries of the former Soviet Union, Kazakhstan ranks 35th in this ranking, Kyrgyzstan-70th, Uzbekistan-71st. We believe that the Republic of Kazakhstan is working in a good direction on the policy of digitalization of the country as a whole.

Conclusion

Although the use of technology (mobile device and computer) is seen at high rates in Kazakhstan, it is not sufficient, especially considering the development of Internet of Things systems in the digitalizing world. Although it is seen that the internet use in our country is on an increasing trend, the rate of internet usage in other countries to the population is higher. The fact that the rate of internet usage in Kazakhstan has increased significantly in recent years is a positive development, and it is an important issue that information technologies have become available. Although this situation is important in terms of catching up with Industry 4.0, internet usage areas should be examined. Access to the internet has become easier with the development of smart phones. As a result, there has been a change in social life. Although the Internet has made our life easier, its conscious and effective use is another problem that needs to be examined in terms of Kazakhstan.

On the other hand, it can be judged that companies in Kazakhstan apply the method of market expansion over the internet insufficiently and very lowly. Compared to other countries, including the private sector and public expenditures, the high levels of R&D expenditure of developed economies is an important indicator that Kazakhstan should expand its activities in this field. Indeed, the task of joining the world's fifty most developed countries cannot be solved without developing the country's innovative potential. On this basis, at a meeting of the Government of the Republic of Kazakhstan in December 2019; The task is to increase spending on education and science to 7% of GDP by 2025. All international rating agencies pay special attention to the fact that Kazakhstan has sufficient innovation potential. In order for Kazakhstan to take its rightful place in the innovation rankings, it would be better to concentrate all resources allocated for the implementation of innovative projects in one hand, rather than spreading issues related to innovative development among various projects and programs; Focus on creating innovative venture firms such as "business angels"; Paying more attention to the creation of specific research and technological-innovative technopolises and technoparks in each region of Kazakhstan; focus on improving tax incentives to attract domestic and foreign investors who import the best know-how into the country; It is necessary to consider the development of public-private partnership in this area.

In order for Kazakhstan to increase its competitiveness on a global scale, it is of vital importance to develop new technology products and increase technology exports. While moving towards Industry 4.0, the primary measure that can be done for Kazakhstan's economy is to establish a commission for the fourth industrial revolution as soon as Germany and the USA have done. The primary goal of this commission should be to determine precisely the measures to be taken in our country for Industry 4.0, the direction of R&D expenditures and innovation.

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Қазақстанның төртінші өнеркәсіптік революцияға сәйкес даму бағыты

Аннотация. Төртінші өнеркәсіптік революция туралы түсінік төртінші өнеркәсіптік революцияға сәйкес Қазақстандағы бағытты анықтауда маңызды. Дамыған 50 елдің тізіміне ену жолында Индустрия 4.0-ге арналған технологиялық инфрақұрылым тұрғысынан Қазақстанның дайындық деңгейін бағалау маңызды. Бұл мақалада «Индустрия төңкерісінің төртінші буынын құрайтын ақылды өндіріс деп аталатын Индустрия 4.0 процесінің әсерлері және осы процеске әсер ететін факторлар қамтылған. Сонымен қатар, осы зерттеуде Қазақстан экономикасы үшін Индустрия 4.0 саласы шеңберінде бағалауға болатын технологиялық өнімнің түрлері және құрылған экономикалық мәні зерттелген. Бұл тұрғыда ғылыми-зерттеу жұмыстары мен білім берудің технологиялық өзгерістер мен трансформацияға әсері ең басты бағыт ретінде қарастыла зерттелді. Осылайша, Қазақстанның Индустрия 4.0 кезеңінің даму үдерісі туралы қорытынды жасауға болады.

Еліміздің экономикасын түбегейлі өзгерту үшін, бәсекеге қабілетті өндірістерді құру көзделеді және технлогиялар мен ғылымды өндіріске енгізіле отырып бәсекеге қабілетті экономикаға қол жеткізуге болады.

Түйін сөздер: Индустрия 4.0, технологиялық даму, инновация, ҒЗТКЖ қызметі,технологиялық өнім, факторлар, технологиялық инфрақұрылым

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Направление развития Казахстана в соответствии с четвертой промышленной революцией

Аннотация. Понятие четвертой промышленной революции важно при определении направления в Казахстане в соответствии с ней. Чтобы войти в список 50-ти развитых стран, важно оценить уровень готовности Казахстана с точки зрения технологической инфраструктуры для Индустрии 4.0. Эта статья включает в себя «эффекты процесса Индустрии 4.0, называемого умным производством, который составляет четвертое поколение промышленной революции, и факторы, влияющие на этот процесс». Кроме того, в настоящем исследовании изучены виды технологической продукции и созданная экономическая сущность, которую можно оценить в рамках отрасли Индустрии 4.0 для экономики Казахстана. В этом контексте было подчеркнуто влияние научно-исследовательской работы и образования на технологические изменения и трансформацию. Таким образом, можно сделать вывод о процессе развития этапа Индустрии 4.0 Казахстана. Для кардинального изменения экономики страны предусматривается создание конкурентоспособных производств.

Ключевые слова: Индустрия 4.0, технологическое развитие, инновации, НИОКР, технологические продукты, факторы, технологическая инфраструктура.

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