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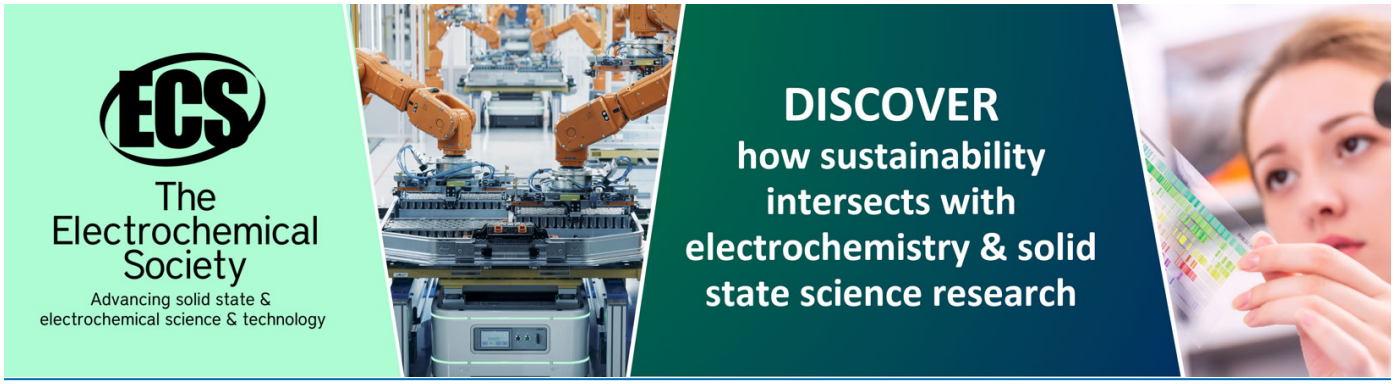

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Formation and development of digital economy in Kazakhstan

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Abstract. The article discusses the current stage of transition to digitization, the role of information and communication technologies (ICT) in the industrial revolution, gives a brief description of technological structures in the world of technical and economic development. The natural resource-based economies of the Republic of Kazakhstan and the Russian Federation are quite similar; therefore, it is appropriate to take into consideration positive aspects of development and share of experiences between the two countries, including that in the field of forming and developing digitization. The main condition for the transformation of the national and global economy into an electronic format is the level of development of the ICT industry. In the article the level and dynamics of the basic indicators of the functioning of the ICT sector in Kazakhstan are analyzed. The analysis of the share of production and services in the ICT industry in relation to GDP in dynamics is presented.GDP dependence on production volumes and ICT services is analyzed using economic-mathematical modelling. Recommendations on using the research results for other territories, including the Russian Arctic zone are given.

1. Introduction

Recently scientists observe economic stagnation caused by slowing down the growth rates of labour productivity, which already started in the 1970s. Researchers believe that everywhere there are going on constructive changes connected to the transition stage between two technological modes when new things begin due to active development of innovations. The influence of factors of scientific and technical progress and innovations will give an impetus for increasing productivity. The slowdown in productivity growth in advanced countries occurred simultaneously with changes at the market of consumer requests, aimed at consumers of deeply individualized products. The explosive development of new technologies, their penetration into all human activities is the reason for transforming the market structure, business models, and structure of participants.

According to the forecasts of scientists, the world is entering one of the long transition periods when new factors replace the usual factors of production growth (natural resources and cheap labour). Taken together, these massive changes are assessed as the “new industrial revolution” (which is often called the “fourth”, or global phase of the industrial revolution). In a narrower sense, they speak of a “technological revolution”, which is based on the transition from mass production of standardized products to flexible, highly efficient production that produces individualized products. At the same time, advanced technologies become “through” processes for all types of production. According to

scientists, innovative or breakthrough technologies will create conditions for improving production processes and will be able to achieve economic growth of 60-80% [1].

The goal of the work is to overview the condition of ICT sector in Kazakhstan, to study the influence of its operation on the level of efficiency of the national economy development using the tools of economic-mathematical modelling as well as potentialities for spreading the results to other territories.

The technological revolution implies a qualitative change in the way of doing economic activities, based on the mass application of technological solutions that can radically increase the productivity of various sectors of the economy and social sphere. Moreover, the technological revolution acts as one of the components of the industrial revolution. The point of view on the existence of six technological structures is universally recognized. According to the concept of Kondratyev N.D., Glazyev S.Yu., there are distinguished periods of dominance of five successive technological structures [2]. The fifth technological structure (since 1980) is defined as the structure of information and communication technologies, and its quality factors are microelectronics, computer hardware and software. They actively generate the creation and continuous improvement of new machines and equipment (computers, CNC, robots, as well as information systems, software for processing information systems, etc.). A characteristic feature of the fifth structure is the disurbanization of the population and the related development of new information and transport infrastructure.

Since the beginning of the 1990s, already during the fifth technological structure, scientists predicted the approach of the sixth order, since new elements began to appear contributing to further changes and a jump in the economy. The main core of the new structure included the electronics industry, computer fibre optic technology, software, telecommunications, robotics, gas production and processing, information services, etc.

The formation of the sixth technological structure changes the ways of coordinating economic relations, the type of society and its needs, the basic resources necessary for them, the types of activities, approaches to R&D and the role of knowledge. The distinctive features of V and VI technological structures, compiled on the basis of the data of [3] are presented in table 1.

The growing volume of information in economic systems and the sixth technological structure do not require a traditional hierarchical structure for constructing organizational activities and communications. Vertical interconnections between structural divisions do not allow responding quickly to increasing external changes, so the most suitable management model is the new model, which is based on cluster-network systems with horizontal connections. Knowledge, in a broad sense, includes the entire supply of information and skills of a person, which allows making decisions and analyze the incoming data [4]. The sixth technological structure is based on the “production of knowledge”. The new aspects characterizing such production are the follows:

- the basis of the value of the goods is knowledge. Today, the cost of a modern car is by 70% formed from design, electronics and other intelligent components. Also for products such as software, the share of knowledge in setting prices is even higher;
- the role of the education system changes with increasing demand for knowledge, including the creation, storage and use of knowledge. Investments in training are recognized as investments in human capital;
- knowledge quickly becomes obsolete. Part of the knowledge mastered during the training cycle loses its relevance, especially if the knowledge is associated with innovative technologies, which causes the need for training throughout the entire working life of a person.

Table 1. The distinctive features o the V and VI technological structures.

Field of characteristics	Technological structure	
	The fifth	The sixth
Forming the network way of coordinating economic relations	System with vertical subordination and managing centre. System of traditional market with price signals	Cluster-network systems with horizontal connections and cooperation mechanism

Development of activities	Extracting and processing industry	Services, education, entertainment, health care, finances, etc.
Prevailing form of knowledge	Explicit	Implicit
Prevalence of innovations	Scientific and technical	Open
Main resources	Capital, entrepreneurial capability	Information, human capital
Approaches to R&D	Growth of investments, into the industry and agriculture	Growth of investments into creative sectors

Source: Compiled by the authors on the basis of the work's data [3]

The development of information technologies has changed the economy significantly. In addition to the emergence and spread of digital enterprises operating exclusively in the electronic environment, significant changes are also taking place at enterprises of the traditional structure. In connection with the development of modern technologies, the main factors of reproduction at the enterprise and, accordingly, the key tasks of the enterprise economy and business management are changing [5].

The development of information systems in all sectors affected not only the sale of goods via the Internet, but also the expansion of market research, data collection, analysis of market participants and updated the processes of payment systems between various agents. Customization of services, development of logistics, flexible pricing, process automation and remote business management play an important role in ensuring the competitiveness of companies. Work with large volumes of data and their management come to the fore in the development of enterprises, industries and states. Today, digital technology allows expanding the capabilities of operational management, which help increasing the speed and effectiveness of management decisions. New organizations are already formed with digital business models. The above processes create the necessary platform for the development of the digital economy, taking into account the capabilities of the traditional economy [6, 7, 8].

According to some experts, the likelihood of digitization for each profession is different. For certain professional groups, the probability is low: doctors, social workers, representatives of creative and engineering professions, mathematicians, scientists and top managers. The most vulnerable professions include: technicians, insurance and tax agents, bank clerks, librarians, telemarketers. For economists, the probability is about 0.43; for accountants and auditors - about 0.9 [9, 10].

The most vulnerable are low-skilled workers. Up to 50% of those employed in the extractive industries may lose their jobs in the future due to the use of self-propelled trucks, forklifts, and drones.

Digital technologies are increasingly pushing to the background the traditional factors of production - capital, labor and land. It is in this regard that digital technologies act as a new method of production, lead to economic growth and significantly increase value added [11, 12].

Development of ICT is dictated by the needs of life itself. At the same time, the complexity and ambiguity of the process determine the importance of deepening cooperation in this area between Kazakhstan and the Russian Federation. The potential available in the Republic of Kazakhstan was the basis for the creation of best practices useful for the Russian Federation in the development of its Arctic zone. Digitization of all spheres of life and the economy of Kazakhstan is an opportunity to take leading positions in the world, as well as improve life quality and create favourable conditions for entrepreneurship development [13]. In December 2017, the State Program "Digital Kazakhstan" was adopted, which developed a set of measures to work in the five key areas [15].The first direction is the digitization of economic sectors, which aims to increase labor productivity in the economy to the level of the first 30 competitive countries of the world, the emergence of competitive export production in priority sectors, capitalization of the largest companies in Kazakhstan, growth of local e-commerce, and a decrease in the share of the shadow economy.

The second direction is the transition to a digital state, which will lead to an increase in the share of public services received in electronic form, the transition of administrative proceedings and partially criminal to electronic format, and the transition of cities to the Smart City format.

The next direction is the implementation of the "Digital Silk Way", which will provide high-speed and safe Internet access as well as high-quality mobile coverage of the entire country, for accelerating development of information and communication technologies (ICT) in Kazakhstan. The fourth direction includes the development of human capital. The universal qualities that a person must possess in the digital age are critical thinking, self-organization, creativity and much more. For their formation, conditions are created, among which there should be noted the digitization of educational processes, development of distance education, introduction of new specialties in universities. The fifth direction, according to the above program, was the creation of an innovative ecosystem. Such an ecosystem develops technological entrepreneurship and innovation, maintaining sustainable links between business, science and the state. Development of the digital economy will lead to dramatic changes in all human activities, ranging from government to purchase of goods by the population. The changes will also affect enterprises, entrepreneurs will no longer need to have large offices or warehouses, and the development of information technologies will improve the processes of goods distribution from manufacturers to consumers. Changing the level of ties between enterprises and economic institutions will make it possible to reduce costs and increase productivity many times [14].

2. Methods of research

At present, the question of assessing the economic, social, and other types of effect of the processes of digitization of the economy has not been sufficiently studied [15, 16]. The main driving force behind the formation of the digital economy, a condition for the transformation of the national and global economy into an electronic format, is the level of development of the ICT industry. The performance indicators of the ICT industry directly affect the level of development efficiency of the digital economy and the national economy as a whole. The main indicators of the functioning of the ICT industry in Kazakhstan according to the standards of national statistical accounting and reporting, compiled according to the website of the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan [19], are presented in table 2.

The table also reflects the dynamics of these indicators through the average annual growth rate. Table 2 shows that for the period from 2007 to 2018, ICT costs on average increased by 8.2% for the year, and GDP for the same period - by 7.22%. The average annual growth rate of electronic retail for the period from 2013 to 2018 amounted to 117.8%. In the ICT industry products are created (computers, software products) and services are provided. For the period from 2007 to 2018, the volume of production in current prices increased annually by an average of 2.7%, and in basic prices there was a decrease by an average of 0.5% per year.

Table 2. Average annual growth rates of the main indicators of ICT functioning in the Republic of Kazakhstan.

Indicator	Period, years	Average growth rate, %
Total expenditures for ICT, mln tenge	2007-2018	108.2
Electronic retail trade, mln tenge	2013-2018	117.8
Electronic wholesale trade, mln tenge	2013-2018	108
Number of transactions made outside Kazakhstan via the Internet using payment cards of Kazakhstan issuers	2013-2018	129.9
Volume of transactions made outside Kazakhstan via the Internet using payment cards of Kazakhstan issuers, mln tenge	2013-2018	128.5
Number of computers in organizations	2004-2018	111.3
Number of organizations using the Internet	2004-2018	113.6

Industrial production in ICT sector (in current prices), mln tenge	2007-2018	102.7
Industrial production in ICT sector (in basic prices), mln tenge	2007-2018	99.5
Volume of services of ICT in actual prices, mln tenge	2005-2018	116.9
Volume of services of ICT in basic prices, mln tenge	2005-2018	111.9

Source: Calculated by the authors on the data of [19]

The services of the ICT industry include: services for placing operating systems and network software; services for placing ready-made database management software; services for downloading ready-made system or application software; services for placing software on the network; design and development services for application programs, networks and systems; consulting services for hardware and software; information technology technical support services; network management services; services for the installation of computers and peripheral equipment; services for the development and processing of sites on the Internet, to provide space or time for advertising on the Internet; computer repair services, peripheral, communication equipment. For the period from 2005 to 2018, an average annual growth of ICT services amounted 16.9%, and that in basic prices - 11.9%.

Expenditures for ICT directly characterize the costs of the Republic of Kazakhstan for the digitization of the national economy. The cost dynamics for the period from 2007 to 2018 according to the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan is presented in Table 3 and in the scatter diagram of Figure 1.

Table 3. Total expenditures for ICT (with the state government organizations taken into account).

Year	Sum, mln tenge	Year	Sum, mln tenge
2007	53 486	2013	220 848
2008	78 159	2014	237 079
2009	126 597	2015	375 600
2010	147 538	2016	269 527
2011	214 180	2017	349 944
2012	309 821	2018	305 217

As can be seen from the nature of the dots' distribution in the diagram (Figure 1), a general stable trend of this indicator is not observed. In this time series, two parts can be distinguished that differ in the nature of the trend: from 2007 to 2012 - cost growth at an increasing rate; from 2012 to 2018 - oscillatory changes in the indicator.

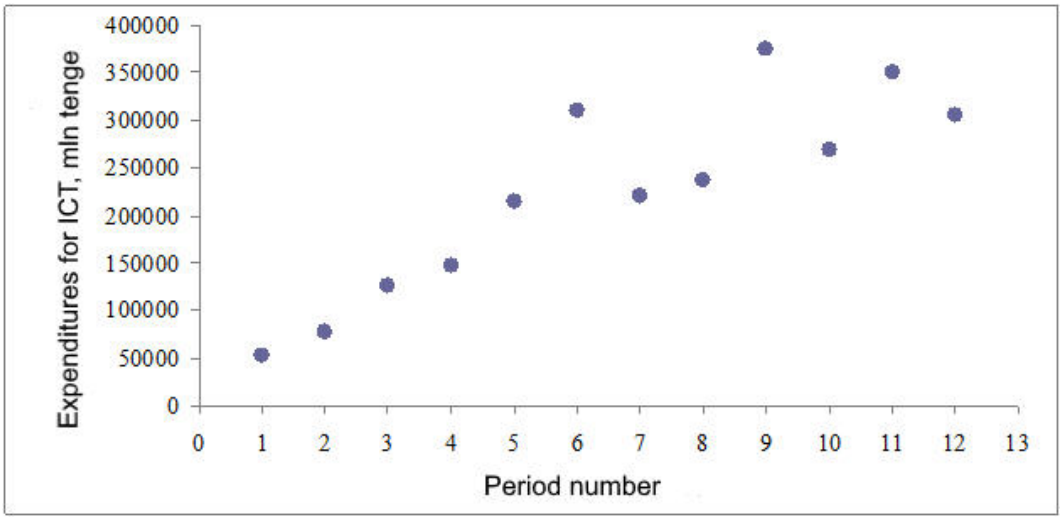

Figure 1. Dynamics of costs for ICT in the Republic of Kazakhstan.

Table 4 presents the results of the forecast of ICT costs for 2019-2020. The forecast of costs is built by the following methods: average absolute increase; trend extrapolation; weighted and non- weighted moving averages; exponential averages.

Taking into account the nature of the dots' distribution in the scatter diagram, the weight to the values calculated by different methods was determined, as well as the final forecast value calculated by the arithmetic average formula. The method of exponential averages allows building a forecast for only one period, so for 2020 the forecast is constructed by four methods.

Table 4. Forecast of expenditures for ICT in the Republic of Kazakhstan for 2019-2020.

Method	2019		2020	
	Forecast value, mln tenge	Weight	Forecast value, mln tenge	Weight
Average absolute increase	328 102	0.1	350 987	0.1
Trend extrapolation	391 367	0.1	414 577	0.1
Non-weighted moving averages	308 229	0.3	321 130	0.4
Weighted moving averages	318 658	0.25	319 759	0.4
Exponential averages	311 853	0.25	-	-
Forecast	322 043	1	332 912	1

In order to assess how high the costs in the economy of Kazakhstan for its digitization are and what is the return from them, it is proposed to calculate these costs per 1000 tenge of GDP and compare with other costs, for example, investment per 1000 tenge of GDP or R&D costs per 1000 tenge of GDP. The calculated values of the proposed indicators are presented in table 5.

Table 5. Expenditures per 1000 tenge of GDP.

Year	Expenditures for ICT, tenge	Expenditures for OC, tenge	Expenditures for GDP, tenge
2007	4.2	264.0	2.1
2008	4.9	262.3	2.2
2009	7.4	269.6	2.3
2010	6.8	213.3	1.5
2011	7.6	177.4	1.5
2012	10.0	176.5	1.7
2013	6.1	168.7	1.7
2014	6.0	166.1	1.7
2015	9.2	171.8	1.7
2016	5.7	165.3	1.4
2017	6.6	165.2	1.3
2018	5.1	187.5	1.2
Average annual growth rate, %	100.9	98.5	97.5

ICT costs per 1000 tenge of GDP per year increase on average by 0.9%, R&D costs decrease by 1.5% per year. In 2007, expenditures for ICT were 2 times higher than that for R&D, and in 2018 already 4.25 times. Analysis of the share of volumes of products and services in the ICT industry in relation to GDP is presented in table 6. The table shows that the share of ICT activities in GDP in 2007 and 2008 was about 0.5%, the highest share was observed in 2009 and 2010, and amounted to 2.98 and 2.58%, respectively. In 2018, the share of ICT products and services amounted to 2.07%. For comparison, we can cite similar data for the United States: information technology over the past five years reached 8% of GDP and provided a quarter of the country's real economic growth [17].

Table 6. Analysis of ICT activities in GDP structure.

Year	Share of industrial production and services in ICT, bln tenge	GDP, bln tenge	Share of ICT production and services, %
2007	62.925	12 849.794	0.49
2008	76.227	16 052.919	0.47
2009	507.104	17 007.647	2.98
2010	561.872	21 815.517	2.58
2011	690.665	28 243.053	2.45
2012	723.919	31 015.187	2.33
2013	802.948	35 999.025	2.23
2014	860.655	39 675.833	2.17
2015	900.408	40 884.134	2.20
2016	967.203	46 971.150	2.10
2017	1 056.094	53 101.282	2.00
2018	1 231.300	59 613.700	2.07

For the factor analysis of the dependence of the GDP of the Republic of Kazakhstan on the volumes of products and services of the ICT industry, it seems appropriate to use the apparatus of correlation and regression analysis and economic and mathematical modeling. In this case, the indicators of table 6 are accepted as initial statistical data.

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3. Results

The economic growth of the Republic of Kazakhstan and the solution of the ambitious task of becoming one of the 30 economically most developed competitive countries in the world largely depend on the successful digitization of all aspects of the country's life and economy. In the Russian Federation, the opportunity to use the progressive experience of the Republic of Kazakhstan in the field of digitization is important for solving the large-scale complex task of developing the Arctic.

The results of the correlation and regression analysis of statistical data confirm the close relationship between the pace of development of the information and communication technology industry and Kazakhstan's GDP growth.

4. Discussion

There are wide opportunities for the successful implementation of the State Program “Digital Kazakhstan”, including five key areas: a) digitalization of economic sectors; b) transition of public administration to an electronic format; c) implementation of the “Digital Silk Road” by providing high-speed and safe Internet access and high-quality mobile coverage of the entire country; d) development of human capital through the digitization of educational processes, the development of distance education, the introduction of new specialties in universities; e)creation of an innovative ecosystem. The role of information and communication technologies and digitization of objects and systems is important for any territory. Each territory as well as Kazakhstan, the Russian Federation and the Russian Arctic zone has its own specificity concerning digitization issues [18-20]. Analysis of the level of knowledge connected to the studied problem and exchange of research results are of undoubted interest both from theoretical and practical points of view.

5. Conclusion

Because of the research for summing up the processes of digital economy formation and revealing the problems of its development the following can be concluded:

First, there is shown the priority role of the factors of scientific and technological progress, innovations in solving the problems of growth in labor productivity, evolution of the global technological and economic development as shift in technological structures in the industrial revolution.

Second, the role of digital technologies in forming the platform for development of digital communications, activities, special approaches to knowledge and technology is identified.

Third, the importance of the state governance in digitalization processes is emphasized. On the example of the Republic of Kazakhstan, a brief overview of the main state directions of the state programs “Digital Kazakhstan” is given.

Fourth, the problem of assessment of the socio-economic effect and efficiency of the digital economy processes and the role of the development level of the ICT sector in this assessment are designated. A comprehensive analysis of the level and dynamics of the main indicators of the ICT sector development in Kazakhstan is carried out. The results of a short-term forecast of ICT costs built using different methods are presented.

Fifth, to assess the efficiency of the digital economy processes a comparative analysis of the ICT costs, investments in R&D per 1000 tenge of GDP is carried out. In addition, share of production and services in the ICT sector in relation to GDP is analyzed in dynamics. The analysis identified the trends of increasing average annual growth rates of ICT costs and decreasing average annual growth rates of R&D costs. The results of factor analysis of the dependence of GDP on the volume of products and services of the ICT sector are presented, which resulted in a mathematical model of this dependence in the form of a polynomial of the second degree, confirming the existence of a direct close relationship.

Sixth, there are a huge number of research results in the field of digitization and the digital economy including that in Russia and its Arctic zone. Each territory has its own specifics of digital processing, while the common development of economic relations of these regions with Kazakhstan and their resources makes it possible to exchange results of scientific research, using approaches and methods of analysis and forecasting in this area.

Targeted management of development of the digital economy aims to significantly increase productivity, ensure economic growth, increase economic well-being of the whole society, and improve life quality of the population.

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