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**METHODOLOGICAL ASPECTS  
OF THE ECONOMY DIGITALIZATION ANALYSIS**

**Abstract.** The purpose of this article is to study the existing methods of analyzing the digitalization of the economy. To achieve this goal, the following tasks were set: to consider the existing definitions of digitalization and the digital economy as directly related, to analyze the methods of various groups and scientists proposed for the analysis of digitalization, to give the main methodological aspects of each method. In the course of the article, methods of Microsoft experts, scientist Semyachkov K.A., the digitization index of the Boston consulting group, the group of the OECD indices and indices used in Kazakhstan were described and analyzed. As statistical methods, statistical analysis, graphical analysis, methods of scientific analysis and synthesis are used. In the end, conclusions about the positive points and shortcomings of each method are presented, after which it was concluded that the e-Intensity index is the most developed.

**Keywords:** digitalization, digital economy, information technologies, methods, indexing

**Introduction**

In the modern world, a new revolution is taking place connected with information. The speed of creation, processing and exchange of information is unprecedented in the entire history of the economic development of mankind and grows exponentially. All this leads to the complication of social and economic relations, both in a single country and in the world economy as a whole. Alongside this, the very value of information itself is growing, including for economic development and increasing the country's competitiveness. Consequently, the role of everything that is connected with information, especially technology and the material and technical base available in the country, and the activity of economic agents and the population in the use of these technologies, also increases. Thus, a new type of economy is formed, closely related to information as such, without being bound to specific products and services. For economic agents, it becomes important not to own the resource as such, but data about this resource, which will affect both the tactical and strategic decisions of the agent himself in the production sphere, but also with respect to other agents. Moreover, information itself can act as a commodity.

In view of all of the above, the introduction of the term "digital economy" is necessary to refer to these changed social relations and a whole new sector affecting transport, financial flows, banking operations, education, healthcare, agent behavior at labor exchanges, securities and resources.

Despite the fact that a lot of research is devoted to issues related to the digital economy, some issues remain unknown, in particular, the effectiveness of existing methods of analyzing digitalization.

At various times, such scientists as Dobrynin A.P., Semyachkov K.A., Panshin B., Babkin A.V., Lakhani K., Yansiti M., Liebenau J., as well as OECD experts were engaged in issues related to the digital economy and the Boston Consulting Group.

## Methods

The general scientific methods of cognition are used in the article: system approach, analysis and synthesis, generalization and concretization, comparison, analogy, measurement, logical analysis and others. In addition, private methods of economic research are used: economic-statistical, factor, structural, expert and rating evaluations, typology, scenario approaches. In the process of the research, methodological approaches and methods for analyzing the level of digitalization of economies have been adapted in the world.

## Main part

According to the Organization for Economic Cooperation and Development (OECD), the number of users of electronic services among adults increases from 60% in 2005 to 80% in 2013, while among youth this figure is 95%, and on average they spend about three hours. According to the same data, in 2013, 77% of enterprises in the OECD countries have at least a website and about 21% trade goods via the Internet. More than 80% of enterprises use e-government services [1].

With the increase in the availability of mobile communications, the speed of information transfer through the Internet, both the number of users and the intensity of data exchange increase, which leads to an even greater increase in the above-mentioned figures. In addition, in 2015, the number of patents related to information technology was one-third of all those registered this year.

The term "digitalization" itself is applicable not only to economic, but also to social phenomena in general and means the transformation of socio-economic relations, which was the result of the widespread introduction and use of digital technologies, i.e. methods and tools for the creation, collection, processing and transmission of information [2].

A great difficulty is the definition of the term "digital economy" - there are at least seven definitions:

- 1) "A global network of economic and social activities that are supported by platforms such as the Internet, as well as mobile and sensor networks" (the Government of Australia),
- 2) "System of economic, social and cultural relations based on the use of digital information and communication technologies" (World Bank Group),
- 3) "The economy that functions primarily through digital technologies, especially electronic transactions carried out via the Internet" (Oxford Dictionary),
- 4) "Business dealing in markets that rely on the Internet and/or the World Wide Web" (UK, BCS),
- 5) "Digital markets that facilitate the trade in goods and services through e-commerce on the Internet" (OECD),
- 6) "An economy capable of providing high-quality ICT infrastructure and mobilizing ICT opportunities for the benefit of consumers, business and the state" (Research Center of the magazine "Economist" and IBM),
- 7) "Production of digital equipment, publishing, media production and programming" (Government of Great Britain) [3].

In addition, there are many disagreements between experts and analysts regarding the interpretation of existing trends in the introduction of digital technologies in the society, the possible consequences of their influence and specific technologies that will have the greatest effect. As a consequence, there are many ways to predict the further development of the world economy, and hence the degree of digitalization of the world economy in general and individual countries in particular.

For example, analysts at Microsoft Corporation suggest that digitalization should be considered as a degree of mass deployment of so-called "technological platforms" - that is, complexes of mutually compatible production technologies, digital distribution channels, and their operation and distribution systems. The basic elements of such platforms will be cloud computing, Internet of things, large data technologies, machine learning [4].

Thus, Microsoft's approach involves analyzing digitalization through the availability of certain, most promising technologies. The advantage of this approach is clarity and accuracy in determining the

gradation of digitalization, which, however, is compensated by the subjectivity of evaluating the most promising technologies, coupled with the lack of a distinct mathematical apparatus for determining the degree of digitization. Thus, this method can be attributed to the method of expert assessments with all the ensuing pluses and minuses of such.

Semyachkov K.A. considered the method when the degree of digitalization is directly related to the development of the economic system as a whole. While the country's economic development directly determines its access to certain technologies through subsidizing research and development activities, and obtaining new technologies from abroad can increase the country's competitiveness. Using the provisions of the asymmetry theory of international trade, he said that the dependence of one country on the other in the field of information technologies leads to an increase in the lag of the dependent country in economic development without the possibility of overcoming it [5].

Therefore, the basis of the digitalization analysis is the determination of the ability of the economic system to ensure the self-reproduction of information technologies with increasing efficiency.

OECD experts have developed a system of indicators that characterize the most important areas for the digital economy:

- 1) The share of the high-tech sector in manufacturing and services.
- 2) The volume of investments in scientific developments, especially those related to the creation of software, as well as the costs of education and staff training.
- 3) Development of own information and communication equipment and its release.
- 4) Creation of additional jobs in the high-tech sector.
- 5) Degree of cooperation between venture companies, large corporations and research organizations.
- 6) The degree of cooperation between universities in the field of innovation.
- 7) Academic mobility.
- 8) Popularity of the Internet.
- 9) Share of high-tech products in exports and imports.

As well as several indicators, generally associated with the availability of digital and mobile technologies [6].

Under the control of the Ministry of Communications and Mass Communications of the Russian Federation and the Federal State Statistics Service, experts from the Higher School of Economics publish a statistical compilation "Indicators of the Digital Economy: 2017". It provides information on the activities of information and communication technology organizations, the information technology sector, the content and media sector, foreign trade in ICT-related goods and services, and data on the digital economy infrastructure indicators. At the same time, most indicators are duplicated in absolute and in percentage terms. The basis of this collection is an array of data processed using statistical methods. Among the most significant indicators are: GVA of the ICT sector, internal costs for research and development related to IT and ICT, publications of national authors in journals indexed in the Web of Science, patent applications for inventions, the proportion of enterprises that use cloud services, broadband Internet, the proportion of the population using the World Wide Web to order goods, services and use of public and municipal services. In addition, the thematic blocks of data are presented using graphical analysis [7].

There is an index of digitalization of the economy E-Intensity, which is calculated on the basis of a weighted average of three sub-indices: infrastructure development, online costs, user activity.

"Infrastructure development" means the development of infrastructure, availability and quality of Internet connection (both mobile and stationary), its share is 50%. "Online expenses» displays the aggregate of expenses for the purchase of goods at retail and online advertising, its share is 25%. "User activity" is also divided into several subindexes of an even lower level: activity of enterprises, consumer activity, activity of state institutions. The share of "user activity" is also 25%. All subindexes are formed on the basis of statistical data for a certain period. As data sources, reports are used by organizations such

as Gartner, Ovum, Pyramid research, Euromonitor, UN E-government survey, The Global Information Technology Report, as well as several additional ones, depending on the need. The index was tested for stability using Monte Carlo simulations [8].

There are also methods for calculating subindexes in the event that there is no data for one or more parameters. Such methods include:

1) Approximation of values based on data from previous periods. First of all, a linear approximation is used by the formula

$$(1) y = mx + b,$$

where:  $m$  – angle of slope of the trend line by the method of least squares,

$b$  – coordinate of the intersection of the axis of abscissas

In addition, it is possible to use the logarithmic approximation by the formula:

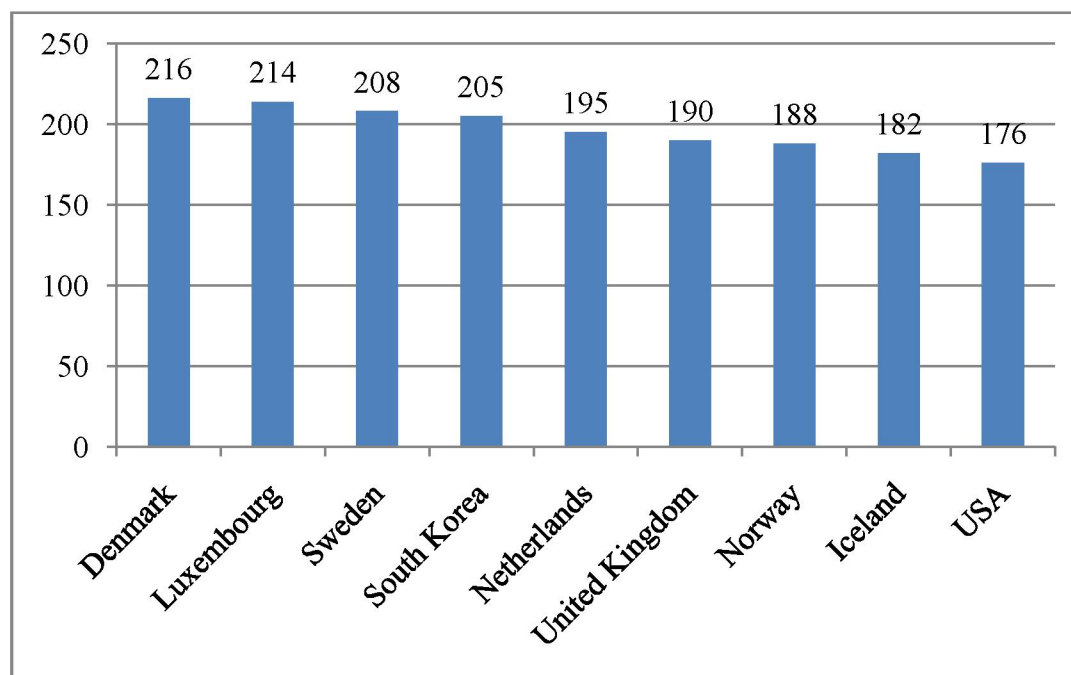
$$(2) y = c * \ln x + b,$$

where:  $c$  and  $b$  are constants,  $\ln$  is the function of the natural logarithm [9].

2) Calculation based on the values of similar parameters from alternative sources. As alternative sources, the above-mentioned additional ratings and statistical data of international agencies or self-collected data can be used.

3) Regressions are based on parameters with which the necessary parameters have a high correlation coefficient. It does not mean the presence of cause-effect relationships, but the simple interconnectedness of the parameters, on the basis of the changes of some, in the presence of a regularity, it will be possible to calculate the necessary ones.

The countries' ratings on the e-intensity index for the most recent reporting period are shown in Figure 1.



Note - compiled by the authors on the basis of source [10]

Figure 1 - The e-intensity index for 2015.

It can be seen from the figure that the most active users of information technologies are enterprises and population of Northern and Western Europe, as well as the United States and South Korea. Together with significant investments in innovation and information technology, this creates a significant basis for strengthening the competitiveness of national economies, as well as providing a cycle of self-reproduction of technologies that will ensure a stable or exponential development of digitalization.

There are several scenarios for predicting the dynamics of the national economies digitalization. Each of these scenarios is based on a certain assumption regarding the structure of the digital economy and its share in the national economy.

The first scenario is considered evolutionary. It is named because of the nature of the digitalization dynamics - the absence of significant changes in the short-term period, the chaotic adaptation of changes with an unknown result in the subsequent selection of the most effective. There are no changes in the structure of the digital economy and its share in the national economy at such scenario. It is most typical for the countries of Latin America, in particular, Venezuela.

The scenario of moderate growth introduces the following assumptions - the main growth due to the consumption of products of the digital economy by the population, while public spending and private investment remain unchanged. This scenario is most typical for the countries of the Middle East.

The latter scenario supposes intensive digitalization, involving foreign investment, government support, and intensive consumption of relevant products by the population. This scenario is most applicable to the countries of East and South-East Asia.

As for the direct analysis of digitalization in Kazakhstan, one of the most relevant methods is presented in the State Program "Digital Kazakhstan" for 2017-2020 (hereinafter referred to as the Program), developed on the basis of the Decree of the President of the Republic of Kazakhstan dated February 1, 2010 "On the Strategic Development Plan Republic of Kazakhstan until 2020".

In this Program, a set of indicators is used for analysis, among which:

- [1] The proportion of Internet users among the population,
- [2] Coverage of the broadcasting of the population of Kazakhstan,
- 3) The level of digital literacy of the population,
- 4) The share of the ICT sector in GDP,
- 5) Growth in labor productivity in ICT,
- 6) The level of satisfaction of the population with the quality of services received in electronic form

[11].

This approach is based on the use of macroeconomic statistics to determine the involvement of economic agents in the use of digital products and the use of digital information technology. With this approach, the level of digitalization can be calculated both directly in the share ratio, and in absolute (in particular, the number of repeated uses of the same service). It is possible to use indexes to sum up the results. The advantage of this approach is the specialization precisely on the needs of a particular country, since it is possible to select critical indicators. However, there are many inaccuracies and shortcomings. First, it is difficult to combine existing indicators into one index, since some of them reflect purely quantitative, and others - qualitative indicators, differing in the same, low accuracy and complexity of information collection. In addition, one of the shortcomings of the approach can be considered insufficient coverage of the commercial sector of the economy, in particular, small and medium-sized businesses that use information technology in their activities. In addition, the development of the information technologies and software development sector is not taken into account. However, given that the method is purely targeted, these minuses are not critical.

## **Conclusions**

To optimize and ensure the development of the digital economy, many different methods of digitalization analysis are used. Despite the fact that there is still no consensus on what a "digital economy" is and what key characteristics it should have, they all agree that the most important role in it should be played by information technologies such as the Internet and telecommunications, and services. In view of this difference in interpretation, there are many ways to determine the development of the digital economy, i.e. digitization depending on the approach.



For example, the approach of Microsoft experts implies the definition of digitalization as the availability of special "technological platforms" for the country's economic agents - complexes of creating, processing and transmitting information, i.e., implies the dominant role of information in digitalization, and under the degree of digitalization - the prevalence of these platforms.

This approach implies the allocation of the most significant factors in the development of the "digital economy", but does not take into account a multitude of less significant separately, but comprehensively significant parameters. In addition, such a method does not imply the use of any mathematical apparatus, since the statistics are quite primitive.

K.A. Semyachkov proposed an approach that implies the interconnectedness of the economy and digitalization through the development of information and communication technologies. In addition, the analysis of the dynamics of digitalization of one country is impossible without taking into account the economic and technological relationship of this country with its neighbors or trading partners.

This approach has a significant advantage in comparison with the previous one, since it also introduces dynamic indicators and indicators of the dependence of one economy on another.

The most developed way to determine digitalization today is the digitalization index e-Intensity - it is calculated on the basis of three sub-indices, each of which is responsible for a certain industry. This index has several sources of data, developed methodological apparatus, tested for falsifiability and the influence of third-party random variables. The downside of this index is only the periodicity of the calculation - at the time of writing the last data of this index were announced in 2015.

In Kazakhstan, the problems of digitalization have been bewildered relatively recently, as evidenced by the Program, which also aims to analyze the degree of digitalization of the economy. The given indicators to some extent reflect the degree of digitalization, but they are incomplete, because they do not take into account the participation of enterprises and their involvement in the digital economy, and does not take into account the degree of development of the software development sector.

In addition, a fairly extensive list of indicators for analysis is used by the experts from the Higher School of Economics of the Russian Federation, but they are not included in the indices and therefore do not reflect the integral picture of digitalization.

In general, for today the toolkit of digitalization analysis is developed enough to make effective decisions regarding the digital economy sector, but still do not have enough factual basis for reliable forecasts.

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### **ЭКОНОМИКАНЫ ЦИФРЛАНДЫРУДЫ ТАЛДАУДЫҢ ӘДІСНАМАЛЫҚ АСПЕКТІЛЕРІ**

**Аннотация.** Мақаланың мақсаты экономиканы цифрландырудың қолданыстағы әдістерін зерттеу болып табылады. Аталмыш мақсатқа қол жеткізу мынадай міндеттер қойылды: өзара тікелей байланысты цифрландыру мен цифрлы экономиканың қолданыстағы анықтамаларын қарастыру, әртүрлі топтар мен ғалымдардың цифрландыруды талдау үшін ұсынған әдістерін талдау, әр әдіс бойынша негізгі әдіснамалық аспектілерді келтіру. Мақала барысында Microsoft сарапшыларының, ғалым К.А. Семячковтың әдістері, Бостон консалтингтік тобының цифрландыру индексі, ЭЫДҰ индекстер тобы және Қазақстанда қолданылатын индекстер сипатталып, талданды. Зерттеу әдістері ретінде статистикалық талдау, графикалық талдау, ғылыми талдау және синтез әдістері пайдаланылды. Қорытындылай келе, әрбір әдістің артықшылықтары мен кемшіліктері туралы тұжырымдар ұсынылып, содан кейін e-Intensity индексінің барынша қолайлы болып табылатындығы туралы қорытынды жасалынды.

**Түйін сөздер:** цифрландыру, цифрлы экономика, ақпараттық технологиялар, әдістер, индекстеу.

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### **МЕТОДОЛОГИЧЕСКИЕ АСПЕКТЫ АНАЛИЗА ЦИФРОВИЗАЦИИ ЭКОНОМИКИ**

**Аннотация.** Целью данной статьи является изучение существующих методов анализа цифровизации экономики. Для достижения этой цели были поставлены следующие задачи: рассмотреть имеющиеся определения цифровизации и цифровой экономики, как непосредственно связанных, проанализировать методы различных групп и ученых, предложенные для анализа цифровизации, привести основные методологические аспекты каждого метода. В ходе статьи были описаны и проанализированы методы экспертов корпорации Microsoft, ученого Семячкова К.А., индекс цифровизации Бостонской консалтинговой группы, группа индексов ОЭСР и индексы, применяемые в Казахстане. В качестве методов исследования используются статистический анализ, графический анализ, методы научного анализа и синтеза. В заключении представлены выводы о положительных моментах и недостатках каждого метода, после чего сделан вывод о том, что индекс e-Intensity является наиболее разработанным.

**Ключевые слова:** цифровизация, цифровая экономика, информационные технологии, методы, индексация.

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