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Theoretical foundations and main stages of the transformation of the digitalization of the economy

Abstract

Object: The relevance of the article is due to the fact that the modern economy is entering an innovative stage of development, and a person with his potential, knowledge, creative thinking, and experience is gaining more and more importance. In the context of the development of the fourth scientific and technological revolution and global digitalization, the usual processes are being transformed and simplified — this is the simplification of access of the population and business to public services, and the acceleration of information exchange, and the emergence of new opportunities for doing business, the creation of new digital products, etc. Over the past decades, the world has been rapidly moving towards a new type of economy, where digital technologies are becoming the main tool for its formation. The expansion of the role of information technology in the work of the private and public sectors is the basis for the transition to a digital state.

Methods: The comparative analysis method used by the authors in the study confirmed the relevance and relevance of digitalization problems, arising from the necessary and irreversible transformation in the digital economy, the introduction of modern digital technologies, resulting the high efficiency of the economy as a whole.

Results: To achieve this goal, the authors analyzed theoretical approaches to the concept of "digital economy", investigated the stages and principles of the transformation of society in the context of the development and formation of Industry 4.0.

Conclusions: As a result of the study, the authors have formed the concept of a digital economy, analyzed the impact of global digitalization on the socio-cultural transformation of society, identified the main indicators of a digital society, determined the stages and principles of transformation of the digitalization process.

Keywords: digitalization, transformation, digital economy, globalization, digital technologies, industrial revolution.

Introduction

The modern world is constantly evolving and changing, and today's digital transformation can be called as an important factor reflecting these changes. The latest technologies are increasingly entering our lives and affect almost every aspect: from living conditions to education, healthcare, finance, and government. Digital transformations have also affected the global economy. They became popular at a breakneck speed in all highly-developed countries.

Currently, the rapid development of a new digital technology revolution is taking place, coupled with cardinal changes in all socio-economic institutions, and sometimes even with the formation of new ones. The ongoing technological changes bring certain challenges to economics when the previous theoretical concepts formed in the pre-digital era stop working.

These challenges have emerged today for economics as well. Practice shows the need for the formation of new theoretical concepts since the existing ones are no longer relevant in modern conditions.

Nevertheless, the digital economy is already a reality, and for its successful functioning in the new conditions, a readjustment of theoretical concepts and their tools is required.

Nowadays, there are many definitions of digital transformation. Some experts are categorically against "freezing" of this concept and its concretization in a stable definition, justifying this by the fact

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that the evolution of digital technologies continues, and the content of this term evolves along with them. However, in our opinion, outlining the boundaries of the essence and content of the term "Digital transformation" is not only an important task but also extremely necessary at the present stage of development of the digital economy, allowing to form a common understanding, and, accordingly, highlight the main directions of digital transformation.

The purpose of the research is to study modern concepts and theories of transformation of the digitalization process in the context of digital technologies use in business.

The subject of the research is the process of transformation of digitalization in the framework of the use of digital technologies.

Literature Review

At the same time, theory lags behind practice: there are still no systematic scientific and theoretical studies that determine the main directions of transformation theories of the digital economy.

Analysis of the scientific literature shows that there are various definitions of categories "digitalization" and "digital economy". A large number of leading foreign and domestic scientists-economists and authors in their works reveal the concepts of "Digitalization" and "Digital economy" and highlight their features.

The interest of a general methodological and theoretical nature for the author's understanding of the problem under study was made up of fundamental works of such foreign authors as N. Nigroponte, D. Tapscott, L. Mesenburg, and others. Among the domestic authors: A. Babkina, V. Matveeva, N. Vasilenko and the team of authors — E. Loshkareva, P. Luksha, I. Ninenko, I. Smagin, D. Sudakov identified several trends that define the image of digital society in the 21st century. Their concepts and theories were examined in detail by the authors of the article during the study. On the basis of their study, the authors theoretical and methodological concept for the research was formed by authors.

Despite the high level of elaboration of the above issues, the theoretical foundations of the transformation of the digitalization of the economy are an urgent problem, since at the present stage development requires a thorough assessment of this process, the most effective proposals for its implementation.

Materials and Method

The theoretical basis of the study was formulated on the scientific works of Russian and foreign researchers and specialists in the field of economic theory, management theory, the theory of institutional transformations, theory of digital economy, as well as scientific and practical developments in the field of innovative development of digital technologies, transformation of IT companies into service integrators.

The methodological basis of the research is formed by the general scientific principles of the systems approach, system analysis, deduction and induction, analysis and synthesis. The use of these methods allows one to objectively perceive the essential features of the concepts of digitalization transformation, as well as the main stages of its development.

Results and Discussion

Broadly, the digital economy can be defined as the economic activity that is driven by the billions of daily online connections between people, businesses, devices, data, and processes. The backbone of the digital economy is the ever-growing interconnection between people, organizations, and technology, which is the result of information and communication technologies.

The concept of "digital economy" was first mentioned in 1995 by the American computer scientist Nicholas Negroponte. According to Nicholas, a "new" type of economy — digital economy has such advantages as the absence of the physical weight of products, replaced by information volume, lower resource costs for the production of electronic goods, several times smaller area occupied by products (usually electronic media), as well as instant global movement via the Internet (Babkin, A.V., 2018).

On the other hand, there is an opinion that this term appeared owing to the Canadian scientist Don Tapscott. In his book "Digital Economy: Promise and Danger in the Age of Networked Intelligence" (Tapscott, Don, 1995), the author does not define the digital economy directly, but uses the concept of "Age of Networked Intelligence", the essence of which "not only in network technologies... but also in the interaction of people through network technologies", which "combine intelligence, knowledge and creativity to make a breakthrough in the creation of social capital and well-being" (Buht, R. & Hiks R.,2018). In other words, Tapscott notes that the digital economy encompasses two types of economic activity. The first informational type means performing basic tasks, for example, loading static infor-

mation on network resources. The second type related to communications includes different activities that have become available via Internet. Thus, the digital economy is characterized by a wider introduction of knowledge about new products and services, an increase in the importance of learning and innovation, globalization and sustainable development.

Over time, Thomas L. Mesenburg points out three main components of the digital economy concept:

- Infrastructure of e-business. It is a part of the entire economic infrastructure used for electronic transactions and electronic commerce. It includes hardware, software, telecommunications, network, human capital.

- Electronic business. It is a model in which business processes, information exchange and commercial transactions are automated using information systems, where the main business processes are transformed with the continuous optimization of products, services and production links.

- Electronic commerce. It includes all financial and trade transactions that are carried out using computer networks and the business processes associated with these transactions. It implies the expansion of the channels for the supply and sale of products by the enterprise, while the offline business is the leading one.

As for a more modern interpretation of the “digital economy” (Figure 1) in the international information space, there are 3 approaches to its definition, namely:

1) The digital economy as an organization for doing business on the Internet;

2) Digital economy as a system of relations based on the use of digital technologies;

3) The digital economy as the organization of a specific production (Saifullina, Yu.M, Serikova, G.S., Assanova, M.A., Amirova, G.N., Akenov, S.Sh., 2021).

Based on the proposed approaches, we can say that the ideas about the significance of the digital economy are diverse. The digital economy in the narrow sense is a type of commercial activity for the production and sale of electronic goods and services, which has three components: 1 — electronic banking, electronic money and electronic commerce; 2 — various sites that earn money from the sale of RAF rivers, online services; internet media (sound recording, cinema, publishing); 3 — production of appropriate equipment and other supporting activities. We understand this based on the definitions provided by the UK Government and the OECD.

By contrast, the World Bank's interpretation is too broad. In this case, it is more specific to talk about the development of digitalization in general or about the digital transformation of society, when new information and computer technologies penetrate into familiar public spheres.

Let us also consider the approaches to definition by contemporary Russian authors. For example, Doctor of Economics, Professor A.V. Babkin and his colleagues provide several definitions to the term “digital economy”:

- a type of economy characterized by the active introduction and practical use of digital technologies for collecting, storing, processing, transforming and transmitting information in all spheres of human activity;

- a complex organizational and technical system in the form of a set of various elements (technical, infrastructural, organizational, software, regulatory, legislative, etc.) with distributed interaction and mutual use by economic agents for the exchange of knowledge in conditions of permanent development (Meyer, P., 2015).

Today, the main role is played by the availability of any resources and the ability to use them in planning activities, rather than possession of it. Alexandra Engovatova, PhD in Economics, Associate Professor of the Department of Economics of Innovation at the Faculty of Economics, Lomonosov Moscow State University, believes that information, its availability, quality, volume, the ability to quickly process it and draw the right conclusions is a fundamental part of the digital economy. Its definition is as follows: “The digital economy is an economy based on new methods of generating, processing, storing, transmitting data, as well as digital computer technologies”. The author emphasizes that “within the framework of this economic model, the existing market business models are undergoing a radical transformation, the model for the formation of added value is changing significantly, the importance of intermediaries at all levels in the economy is sharply reduced”. Alexandra Engovatova also highlights the increasing importance of an individual approach to product formation (Ria novosti, 2017).

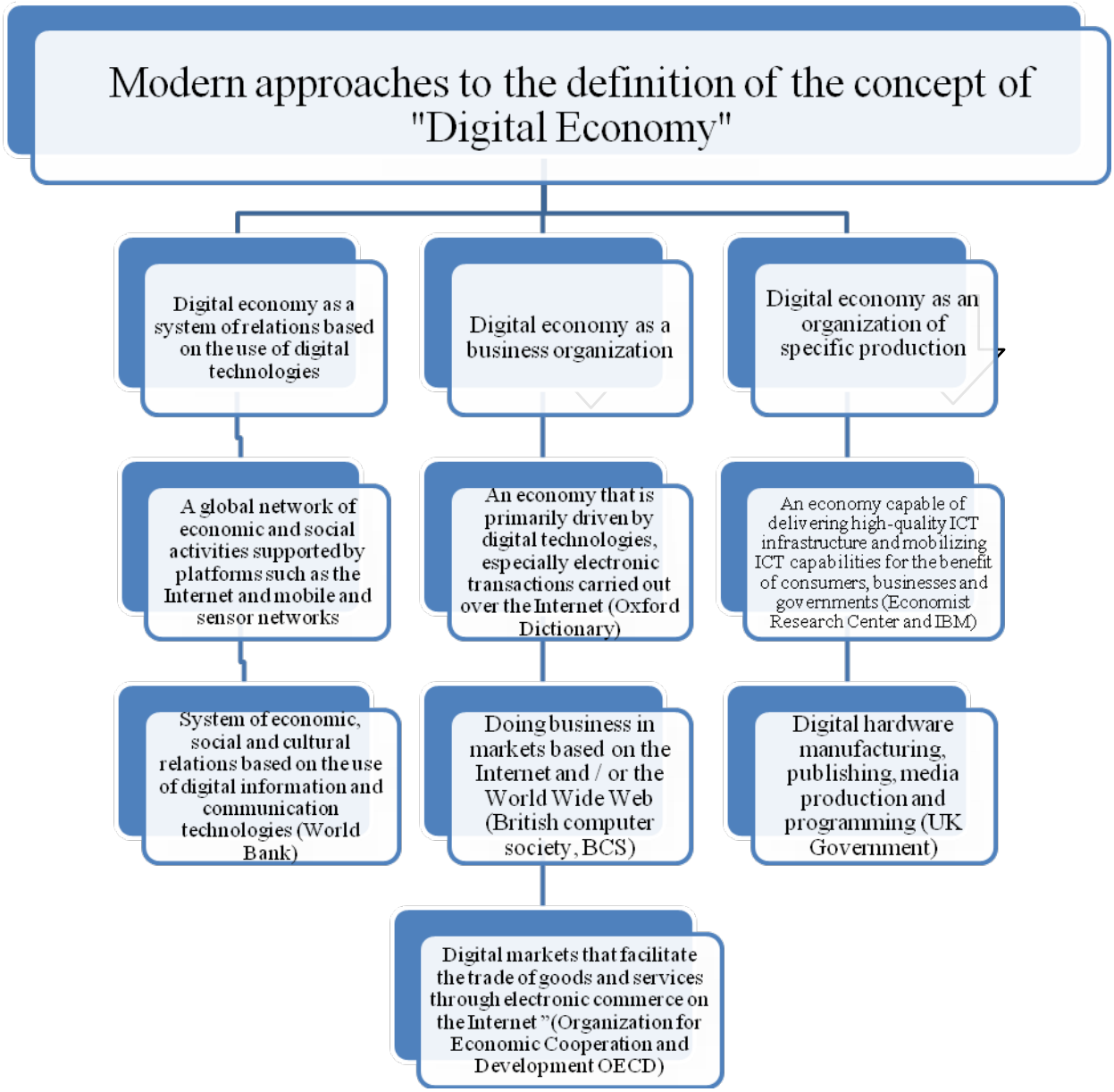

Figure 1. Modern approaches to the definition of the concept of "Digital economy"

Note — Compiled by the authors based on (Babkin,2018)

V.M. Matveeva views the digital economy as "a paradigm for accelerating economic development through digital technologies", citing the World Bank Annual Report 2018.

N.V. Vasilenko offers a more universal definition, defining it as "a type of economy characterized by the active introduction and use of digital technologies for storing, processing and transmitting information in all spheres of human activity" (Vasilenko. N.V., 2017). A similar position is held by I.V. Sudarushkina and N.A. Stefanov – they consider the digital economy as the result of the transformational effects of new general-purpose technologies in the field of information and communication, which affect all sectors of the economy and social activity (Sudarushkina, I. V. & Stefanova, N.A., 2017).

Analyzing the works of Russian scientists, the approach of Keshelav A.V. seems to be the most interesting.

He points out the merging of the real and virtual worlds into a new, hybrid one. This new world is subject to different laws and regulations. In it, all the vital actions of the real world can be performed through

the virtual world, while an important condition is the wide availability of the digital infrastructure. Hence, the definition is born that the "Digital" economy is an economy that exists in a hybrid world. The "digital" economy is aimed at the maximum realization of the individual needs (material and social) of a person who exists in a hybrid world (Keshelav, A.V., Budanov, V.G., Rumjancev, V.Ju., 2017). This definition is absolutely correct and reflects the essence, however, it does not give an understanding of the upcoming changes and, accordingly, it is difficult to use it in a practice.

Summarizing, it can be determined that the core of the digital economy is the sector for the production of digital goods and the provision of services related to digital technologies. Enterprise investing in research related to digital innovation is increasing, which means that the digital sector plays a key role in innovation. The digital infrastructure is also becoming more accessible, the quality of communication networks is improving as 4G and fiber-optic data transmission technologies are introduced (Tan, N.N., Ngan, H.T.T., Hai, N.S., Anh, L.H., 2021).

In addition to research by Russian scientists, the definition of this phenomenon is disclosed in the Decree of the President of the Republic of Kazakhstan in the State Program "Digital Kazakhstan" Decree of the Government of the Republic of Kazakhstan dated December 12, 2017 No. 827: "Digitalization of economic sectors" — transformation of traditional sectors of the economy of the Republic of Kazakhstan using breakthrough technologies and opportunities, which will increase labor productivity and lead to an increase in capitalization (State Program "Digital Kazakhstan", 2017, 12 December).

The definition used in the Strategy is correct, but a little difficult to use.

Thus, having analyzed the various approaches of modern authors to the definition of the digital economy, we can offer the following functional interpretation, which will be used in this work:

"Digital" (electronic) economy is an economy, a characteristic feature of which is the maximum satisfaction of the needs of all its participants through the use of information, including personal information. This becomes possible owing to the development of information, communication and financial technologies, as well as the availability of infrastructure, which together provide the possibility of full interaction in the hybrid world of all participants in economic activity: subjects and objects of the process of creation, distribution, exchange and consumption of goods and services.

The digital economy is characterized as a reflection of the transition from the third to the fourth industrial revolution. If the third industrial revolution marked the transition from mechanical and electronic devices to information systems that provide intensive automation and robotization of production processes, then the fourth one is based on the digital revolution, which implies the integration of computing resources into physical processes, where open information systems, equipment and sensors are connected throughout the entire value chain, interact with each other and go beyond a single enterprise or business.

Owing to the industrial revolution, individual countries have been able to achieve impressive rates of economic growth. This led to the fact that for many decades they became the leaders of the world economy. The fourth industrial revolution, known abroad as Industry 4.0, was first discussed in 2011. This concept was introduced by the German federal government as a part of the formation of a strategic plan for the development of the industrial sector in Germany. The strategy is based on the integration of information systems and industrial equipment into a single information space. This allows to build interaction between elements and interact with the external environment, bypassing human participation.

The numbers "4.0" mean that this direction of industrial development has such a great potential that it will inevitably lead to the fourth industrial (industrial) revolution.

The first industrial revolution falls on the late 18th–early 19th centuries. It began with the invention of the first steam engine by James Watt, which created the initial industrialization. The first industrial revolution was caused by the transition from an agricultural economy to industrial production, with the help of to invention and other innovations: spinning cotton threads using a loom, the invention of mechanical devices, the development of metallurgy through the use of coke, the development of steam transport. From 1820 to 1900, GDP per capita in 12 leading European countries increased threefold, from $1,000 to $3,000 (Sullivan, J., 2017).

The second industrial revolution took place in the second half of the XIX century to the beginning of the XX century. During this period, electric energy was discovered and its active use at enterprises began, the first telegraph and telephone were invented, and the construction of railways was actively developing. In addition, the conveyor belt was invented and applied by Henry Ford. This contributed to the accelerated production of cars, which made them more accessible to the population. This revolution led to the rapid development of life.

In 1960s, when the economy of European countries was recovering from the consequences of the war, the third revolution began. This period is characterized by the invention of the computer, the development of numerical control and microprocessors, which over time started to be used in production. This entails intensive automation and robotization of production processes.

Despite the active introduction of various types of information and communication technologies (ICT), electronics and industrial robotics in production processes, industrial automation, which began at the end of the 20th century, was predominantly local in nature, when each enterprise or divisions within one enterprise used its own control system (or their combination) that were incompatible with other systems.

The development of the Internet, ICT, sustainable communication channels, cloud technologies and digital platforms, as well as the information "explosion" of data escaping from different channels provided the emergence of open information systems and global industrial networks that go beyond the boundaries of an individual enterprise and interact with each other. Such systems and networks have a transformative impact on all sectors of the modern economy and business outside the ICT sector itself, and are moving industrial automation to a new fourth stage of industrialization.

Figure 2 shows the key changes in technology and manufacturing that characterize the transitions from the first to the fourth industrial revolution.

Thus, any industrial revolution in the transition from one historical period to another is based on three main components:

- raw materials, as well as sources and methods of energy transmission;
- technology;
- organization of production and management.

At the end of the 18th century, the main raw materials were coal and iron, the main technologies were steam and the conversion of thermal energy into mechanical energy. As for the mechanization and organization of management, they, as such, were absent then, except that there was a Watt regulator on the steam engine. In the second half of the 19th and early 20th centuries, with the advent of electricity, opportunities opened up for starting work on the scientific organization of labor, conveyors, the ideas of Taylorism appeared. Somewhat later, works on the theory of automatic control and various kinds of tabulators appeared (Ferra.ru,2018).

The fourth stage of the industrial revolution is described through the introduction of "cyber-physical systems" into factory processes. It is understood that these systems are transformed into one common network to communicate and interact with each other in real time, self-adjust and learn new patterns of behavior. They help to align production, reduce the possibility of errors, interact with the manufactured goods and, if necessary, will be able to adapt to changing consumer needs. Industry 4.0 has an impact not only on the production process, but also on the services related to the products that it produces.

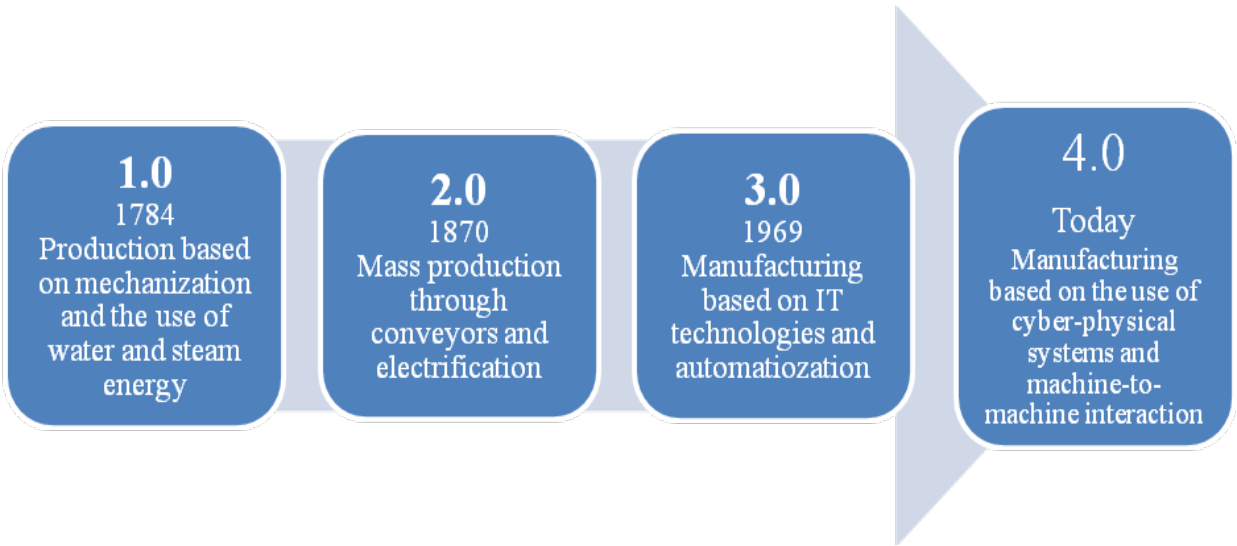

Figure 2. Change in production technologies from the first to the fourth industrial revolution

Note — Compiled by the authors based on (Tarasov, 2018).

Cyber-physical production systems will fundamentally change the traditional logic of production, since each worker will be able to choose exactly the product that will be able to reproduce, autonomously, without the participation of an operator. This completely new architecture of industrial systems can be implemented gradually through digital upgrades of existing manufacturing facilities. That is, this concept can be implemented not only at new enterprises, but also gradually deployed at existing ones in the process of evolutionary development. Thus, the concept of the fourth industrial revolution is based on four principles:

- Interoperability (interoperability between man and machine) — the ability of various sensors, devices, and people to contact each other directly via the Internet;

- Virtuality — transparency of information and the ability of systems to create a virtual copy of the physical world, its objects, functions, systems and processes. There is a constant exchange of data between the original and the digital copy, which takes place in production or with a specific "smart" product;

- Working in real time — connected with the technical assistance of machines to humans: combining large amounts of data, using cloud computing technologies and performing a number of tasks that are unsafe for humans. This allows the operator to make an informed decision based on the collected and analyzed data;

- Decentralization — the ability of cyber-physical systems to make independent, independent of people, decisions, while the staff is only a controller, so that in case of emergency situations they can quickly connect and correct the current situation (Digital.gov.ru, 2021).

Conclusions

In conclusion, the main results obtained by authors of this article are as follows:

- Based on the considered approaches, we can say that the ideas about the significance of the digital economy are diverse. "Digital" (electronic) economy in a broad sense is an economy, a characteristic feature of which is the maximum satisfaction of the needs of all its participants through the use of information, including personal information. The digital economy in the narrow sense is a kind of commercial activity for the production and sale of electronic goods and services, which has three components: electronic money, various sites, and the production of related equipment and other supporting activities.

- The digital economy is characterized as a reflection of the transition from the third to the fourth industrial revolution, which implies the integration of computing resources into physical processes, where open information systems, equipment and sensors are connected throughout the entire value chain, interact with each other and go beyond the framework of a single enterprise, or business.

- The fourth stage of the industrial revolution is described through the introduction of "cyber-physical systems" into factory processes, which can be implemented not only at new enterprises, but also gradually deployed at existing ones in the process of evolutionary development. The concept of the fourth industrial revolution is based on four principles: interoperability, virtuality, real-time operation, and decentralization.

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С.С. Шакеев, К.А. Невматулина, Ж. Владимиров

Экономиканы цифрландыруды трансформациялаудың теориялық негіздері мен негізгі кезеңдері

Аңдатпа

Мақсаты: Мақаланың өзектілігі қазіргі экономиканың дамудың жаңа инновациялық кезеңіне енуіне байланысты және оның әлеуеті, білімі, шығармашылық ойлау қабілеті мен тәжірибесі бар адам барған сайын маңызды бола түсуде. Төртінші ғылыми-техникалық революцияның дамуы мен жаһандық цифрландырудың мәнмәтінінде үйреншікті процестер түрленіп, жеңілдетіледі — бұл халық пен бизнестің мемлекеттік көрсетілетін қызметтерге қол жеткізуін оңайлату, ақпарат алмасуды жеделдету және бизнес жүргізу үшін жаңа мүмкіндіктердің пайда болуы, жаңа цифрлық өнімдерді жасау және т.б. Соңғы онжылдықтарда әлем цифрлық технологиялар, оны қалыптастырудың негізгі құралына айналатын жаңа типтегі экономикаға бет бұруда. Жеке және мемлекеттік секторлардың жұмысында ақпараттық технологиялардың рөлін кеңейту цифрлық мемлекетке көшу үшін негіз болып табылады.

Әдісі: Авторлар зерттеуде қолданған салыстырмалы талдау әдісі экономиканың жоғары тиімділігіне байланысты цифрлық экономикада қажетті және қайтымсыз трансформацияға, заманауи цифрлық технологияларды енгізуге байланысты цифрландыру проблемаларының өзектілігін қажет екендігін растады.

Қорытынды: Қойылған мақсатқа жету үшін авторлар «цифрлық экономика» ұғымының теориялық тәсілдерін талдады және 4.0 индустриясының дамуы мен қалыптасуы контексіндегі қоғамды трансформациялаудың кезеңдері мен принциптерін зерттеді.

Тұжырымдама: Зерттеу нәтижесінде авторлар цифрлық экономика ұғымын қалыптастырды, жаһандық цифрландырудың қоғамның әлеуметтік-мәдени трансформациясына әсерін талдады, цифрлық қоғамның негізгі индикаторлары анықталды, цифрландыру процесін трансформациялаудың кезеңдері мен принциптері айқындалды.

Кілт сөздер: цифрландыру, трансформация, цифрлық экономика, жаһандану, цифрлық технологиялар, өнеркәсіптік революция.

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Теоретические основы и основные этапы трансформации цифровизации экономики

Аннотация

Цель: Актуальность статьи обусловлена тем, что современная экономика вступает в новый инновационный этап развития, и человек с его потенциалом, знаниями, креативным мышлением и опытом приобретает все большее значение. В контексте развития Четвертой научно-технической революции и глобальной цифровизации привычные процессы трансформируются и упрощаются — это и упрощение доступа населения, и бизнеса к государственным услугам, и ускорение обмена информацией, и появление новых возможностей для ведения бизнеса, и создание новых цифровых продуктов и т.д. За последние десятилетия мир стремительно движется к экономике нового типа, где основным инструментом ее формирования становятся цифровые технологии. Расширение роли информационных технологий в работе частного и государственного секторов является основой для перехода к цифровому государству.

Методы: Метод сравнительного анализа, используемый авторами в исследовании, подтвердил актуальность и востребованность проблем цифровизации, которые обусловлены необходимостью и необратимостью

трансформации в условиях цифровой экономики, посредством внедрения современных цифровых технологий, благодаря которым повышается эффективность экономики в целом.

Результаты: Для достижения поставленной цели авторами проанализированы теоретические подходы к понятию «цифровая экономика» и исследованы этапы и принципы трансформации общества в контексте развития и становления Индустрии 4.0.

Выводы: В результате исследования авторами сформировано понятие цифровой экономики, проанализировано влияние глобальной цифровизации на социокультурную трансформацию общества, выделены основные индикаторы цифрового общества, определены этапы и принципы трансформации процесса цифровизации.

Ключевые слова: цифровизация, трансформация, цифровая экономика, глобализация, цифровые технологии, промышленная революция.

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