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# *The influence of digital technologies on the development of economic subjects*

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***Abstract*** — **The article analyzes the impact of digital technologies on the results of economic activity, highlights the main directions of digital transformation, as well as the features of modern economic processes. The authors analyzed the business digitalization index, the intensity of using digital technologies by organizations in different countries and main development indicators of the information society in the Russian Federation. The correlation analysis of digital technologies influence on the level of GDP is carried out. The article suggests a relational model of activities interaction arising in the process of an economic subject development analyzed by the universal categorical method "Pentagram" that reflects the ancient Chinese philosophy "Wuxing", which is a more complete and accurate representation of economic subjects as it highlights their essence based on the dependence of real economic results and trends of the modern economy digitalization. In conclusion, the authors analyzed the involvement of digital technologies in the development of the economy showing the drivers of development for each directions of economic activity digitalization.**

***Keywords — digital economy, digital technologies, digitalization index, economic development***

## I. INTRODUCTION

The trends of modern economy development are characterized, first of all, by the rapid expansion of digital technologies influence on all spheres of economic subjects' activity. The innovative and informational activity is growing, the ways of creating and strengthening the inter-firm interactions, the motives in cooperation and the principles of market behavior are changing as well as.

The processes of digital transformation affecting business, state and society allow all stakeholders to obtain qualitatively new results from their activities that lead to the overall development of the economy.

In general, digital transformation was initially understood as the translation of traditional data into a digital format. However, in the modern world this concept covers much more areas.

First of all, it is a complete digitization of the economy. This is due to the introduction of digital platforms and technologies for processing big data, the creation of infrastructure for storing information and the creation of the trusted digital space.

The second direction is the development of technologies that determine the transition to the digital economy:

- data technologies (artificial intelligence, cloud computing, quantum technologies, supercomputer technologies, identification technologies, mathematical modeling, end-to-end technologies, blockchain technologies, neural networks);
- production technologies (cyberphysical systems, additive manufacturing, robotics, open production technologies);
- environment technologies (unmanned technologies, paperless technologies, mobile technologies, biometric technologies, brain-computer technologies).

The third direction includes the trends of industry digital transformation. It is the Industrial Internet of Things and robotic technologies, unmanned production, cloud technologies, creation of unified information system for end-to-end integration of management and production processes, electronic data interchange, engineering software, business process modeling, monitoring and control through mobile technologies, industrial analytics, personalization of goods, electronic retailing, status tracking, predictive maintenance, quality forecasting, instant response, and jobs digitalization.

This area is also characterized by the development of service business models.

As the fourth direction includes the processes connected with new management systems. Digital technologies allow to provide:

- high-speed decision-making and instant response to any changes in the environment;

- user-friendly orientation;
- one-touch solutions;
- management automating big data analysis,
- real-time data acquisition.

The specifics of modern economic processes are the following [1]:

- the emerging global ecosystem of digital economy and global digital space;
- the creation of a qualitatively new structure of economic assets that meet the economic priorities of the digital economy;
- the creation of approaches to the organization of production industries, trade, services, taking into account the achievements of the digital economy and effective in the conditions of formation and development of the global digital space;
- the creation of effective management principles for formed economic assets (resources) as well as the management improvement of existing ones;
- the creation of conditions for active participation of the business community and the civil society in the process of digital economic space development by creating attractive organizational and regulatory conditions as well as the space of trust in the digital environment;
- the creation of a system to ensure the security and sovereignty of the national space of the digital economy.

Nowadays there are a lot of studies devoted to the influence of digitalization on the economic subjects' activities provided by Russian researches [1], [2], [3], [4], [5] as well as foreign authors [6], [7], [8], [9]. All of them share the view that digital technologies gradually but rather rapidly enter all spheres of life, change organizational and economic processes, transform the principles of communication between all members of interaction.

Thus, the topic of digital technologies influence on the development of the economy as a whole, and individual economic subjects in particular, becomes relevant, that determined the necessity of this study.

## II. METHODOLOGY

The aim of this research is to study the impact of digital technologies on the results of economic activity. The research methods are logical and system analysis methods. The specificity of the problems determined the structure of the study. It was necessary to analyze the indicators of digitalization and the intensity of digital technologies usage in the modern economy.

The research algorithm included the following steps:

- the study of scientific research reflected in the periodicals devoted to the trends of digital economy development;
- the identification of digital technologies affecting the development of economic subjects;
- the creation of the authors' vision upon the processes occurring during the digital transformation of the economy.

## III. THE RESULTS OF THE RESEARCH

The digital revolution was the largest and fastest-growing technological revolution in human history, requiring significant changes and innovations in the management of socio-economic systems [10].

For an integrated assessment of digital technology diffusion level in the business sector, the HSE Institute for statistical research and knowledge economy has developed a business digitalization index (Chart 1) [11].

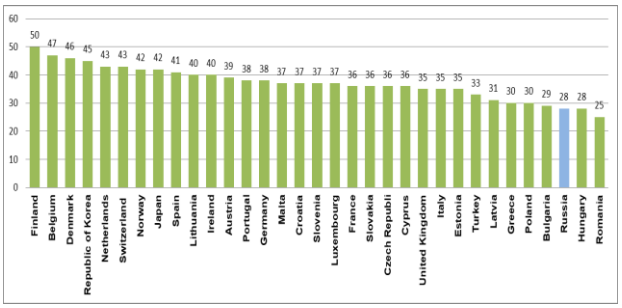

Chart 1 - Business digitalization index in countries, 2019

The peculiarity of this index is to determine the speed of adaptation of economic subjects to digital transformation through the use of ERP-systems, cloud services, broadband Internet, RFID-technologies, and e-Commerce technologies. The study was conducted according to the countries of Europe, the Republic of Korea, Turkey, Russia and Japan. The leader, according to picture 1, was Finland (index value of 50 points). The top five also included Belgium (47), Denmark (46), the Republic of Korea (45), the Netherlands and Sweden (43). Russia (28 points) is on a par with such Central and Eastern European countries as Bulgaria, Hungary, Poland and Romania, lagging behind the first points almost twice.

The intensity of some digital technologies usage varies from country to country, both by type and level (Table 1) [11].

In 2018, the use of cloud services decreased for leading Finland (from 66 to 65 points), but the use of electronic sales using special forms posted on the website / extranet, EDI-systems increased (from 21 to 24 points). For Russia, the growth in the use of broadband Internet and cloud services amounted to 4 points (from 82 to 86 and from 23 to 27 points, respectively), ERP-systems and electronic sales using special forms posted on the website / extranet, EDI-systems was 3 points (19-22 and 12-15, respectively) and RFID-technologies

– 1 point [12]. The growth of these indicators shows the awareness of the importance of the of digital technologies introduction by economic subjects in their activities to ensure further economic development.

TABLE I. THE INTENSITY OF DIGITAL TECHNOLOGIES USAGE IN ORGANIZATIONS IN COUNTRIES, 2017

| | Broadband Internet | Cloud services | RFID-technologies | ERP-systems | Electronic sales using special forms posted on the website / extranet, EDI- system |
|---|---|---|---|---|---|
| Denmark | 100 | 51 | 9 | 40 | 29 |
| Lithuania | 100 | 23 | 10 | 47 | 22 |
| The Netherlands | 100 | 35 | 18 | 48 | 16 |
| Finland | 100 | 66 | 23 | 39 | 21 |
| Latvia | 99 | 12 | 9 | 25 | 11 |
| Slovenia | 99 | 22 | 15 | 30 | 18 |
| France | 99 | 17 | 11 | 38 | 17 |
| Austria | 98 | 21 | 19 | 40 | 17 |
| Belgium | 98 | 40 | 21 | 54 | 24 |
| Spain | 98 | 24 | 15 | 46 | 20 |
| Portugal | 98 | 23 | 11 | 40 | 18 |
| The Republic of Korea | 98 | … | 42 | 28 | 11 |
| The Czech Republic | 98 | 22 | 8 | 28 | 24 |
| Luxembourg | 97 | 19 | 18 | 41 | 8 |
| Sweden | 97 | 48 | 12 | 31 | 29 |
| Ireland | 96 | 36 | 11 | 28 | 30 |
| Italy | 96 | 22 | 13 | 37 | 8 |
| Cyprus | 96 | 22 | 14 | 35 | 12 |
| The United Kingdom | 95 | 35 | 8 | 19 | 20 |
| Germany | 95 | 16 | 16 | 38 | 24 |
| Malta | 95 | 28 | 17 | 30 | 17 |
| Poland | 95 | 10 | 9 | 26 | 10 |
| Slovakia | 95 | 22 | 18 | 31 | 15 |
| Turkey | 95 | 10 | ... | 14 | 11 |
| Croatia | 95 | 31 | 14 | 26 | 18 |
| Estonia | 95 | 23 | 12 | 28 | 16 |
| Norway | 94 | 48 | 10 | 30 | 29 |
| Hungary | 91 | 16 | 7 | 14 | 13 |
| Japan | 91 | 47 | 5 | ... | 24 |
| Bulgaria | 89 | 8 | 18 | 23 | 7 |
| Greece | 85 | 11 | 7 | 37 | 11 |
| Russia | 82 | 23 | 6 | 19 | 12 |
| Romania | 82 | 11 | 7 | 17 | 8 |

On the example of Russia, the authors conducted a correlation analysis of the impact of digital technologies on the level of GDP per capita (Table 2) [13].

TABLE II. THE MAIN INDICATORS OF INFORMATION SOCIETY DEVELOPMENT IN THE RUSSIAN FEDERATION

| Indicator name | Unit of measure | 2015г. | 2016г. | 2017г. |
|---|---|---|---|---|
| The volume of investments in fixed assets for equipment for information and communication technologies, in actual prices | million rubles | 304987,7 | 284667,7 | 389698,3 |
| Share of organizations using Extranet in the total number of organizations surveyed | percent | 16,9 | 15,0 | 16,6 |
| Percentage of organizations using open source operating systems provided by third parties (e.g., Linux) in the total number of organizations surveyed | percent | 17,3 | 16,6 | 17,3 |
| Share of organizations that used the Internet in the total number of surveyed organizations | percent | 88,1 | 88,7 | 88,9 |
| Share of organizations with a website in the total number of organizations surveyed | percent | 42,6 | 45,9 | 47,4 |
| Share of organizations that used e-mail in the total number of surveyed organizations | percent | 84,0 | 87,6 | 88,3 |
| Percentage of organizations that provided technical means for mobile Internet access to their employees in the total number of surveyed organizations | percent | 30,3 | 32,3 | 33,4 |
| Percentage of organizations that had special software to manage procurement of goods (works, services) in the total number of surveyed organizations | percent | 38,4 | 37,8 | 36,2 |
| Share of organizations that had special software to manage sales of goods (works, services) in the total number of surveyed organizations | percent | 21,9 | 21,8 | 22,0 |
| Share of organizations that used ERP-systems in the total number of surveyed organizations | percent | 9,3 | 10,7 | 12,2 |
| Share of organizations that used CRM-systems in the total number of surveyed organizations | percent | 9,9 | 9,4 | 10,3 |
| Share of organizations that used electronic document management systems in the total number of surveyed organizations | percent | 62,7 | 66,1 | 66,1 |
| Percentage of organizations that used electronic data interchange between their own and external information systems by exchange format in the total number of surveyed organizations | percent | 59,6 | 62,4 | 63,1 |
| Share of organizations using SCM systems in the total number of organizations surveyed | percent | 4,3 | 4,4 | 4,7 |
| Share of organizations that placed orders for goods (works, services) on the Internet in the total number of surveyed organizations | percent | 41,3 | 41,6 | 41,2 |
| Share of organizations that received orders for manufactured goods (works, services) via the Internet in the total number of surveyed organizations | percent | 18,2 | 19,3 | 20,1 |

The correlation analysis confirmed the existence of a strong direct dependence of GDP per capita on the following:

- the volume of investments in fixed capital in equipment for information and communication technologies;
- the share of organizations using the Internet;

- the share of organizations having a website;
- the share of organizations using e-mail;
- the share of organizations providing technical opportunities for mobile Internet access to their employees;
- the share of organizations using ERP systems;
- the share of organizations using electronic document management systems;
- the share of organizations using electronic data exchange between their own and external information systems;
- the share of organizations using CRM systems;
- the share of organizations placing their orders for goods and services on the Internet.

Thus, the undeniable importance of digital technologies for the development of the modern economy is illustrated.

## IV. Results and discussion

On the basis of conducted study the authors highlighted the importance of digital technologies integration in the process of development strategy creation for any economic subject. It is suggested to apply a relational model of activities interaction arising in the process of an economic subject development analyzed by the universal categorical method "Pentagram" that reflects the ancient Chinese philosophy "Wuxing", and is based on the notion that each object is the result of mixing primary phases (Wood, Fire, Earth, Metal, and Water) in different proportions.

The object of study is placed in the pentagram and is interpreted in its terms by the use of the method. As a categorical method of cognition, the pentagram is a pentagon with a five-pointed star placed in it, representing a cyclic structure reflecting a certain completed process. This allows us to identify and interpret different types of relations between components of the studied object depending on their location relative to each other. Since the pentagram reflected the completed cycle, it assumes the beginning and the end of certain processes that go through five stages. The economic subject described by this method (a separate organization, region, and industry) appears precisely as an evolving object that first arises, and then successively passes through several stages of behavior change, acquiring at each a new qualitative characteristic, the carrier of which is a new component (Figure 1).


Fig 1. The cycle expressed through the pentagram “Wuxing”

*The phase of Water.* It is the initial element; it is an undifferentiated state of the object. It corresponds to the selected component "Production", which is perceived as the initial stage of an economic subject functioning. This component is characterized by simple purposes and principles of market behaviour. If the core of an economic subject consists only of this component, it can be characterized by the presence of homogeneous or weakly differentiated products, weakly specific production factors, and simple technologies.

*The phase of Wood.* It characterizes the stage of the object "prosperity". It implies the exit of an economic subject from the concentration on internal processes into the external environment and the beginning of dynamic progressive development through the search for competitive advantages. It allows the economic subject to become more developed, productive and competitive by improving the resulting raw materials, components, more advanced and productive machinery and equipment, and tools.

*The phase of Fire.* It is the most active (and therefore the most resource-consuming) element of the pentagram. Here we mean the “Research” component, the purpose of which is to support the growth and productivity of an economic subject, to strengthen its innovativeness. In the process of its creation, therefore, there will be expanded interaction related to R&D, interaction with research organizations, innovation-oriented enterprises. It also allows economic subjects to start the processes of commercialization of research results, technology, knowledge, and know-how (which are improved with the development of the next component of the event).

*The phase of Earth.* It is a balancing element. It corresponds to the component "Education", which balances the economic subject in terms of compliance of the characteristics of its internal labor resources with the changing requirements of innovation and economy networking.

*The phase of Metal.* It is the final logical element. According to the study conducted by the authors, it is the component of digital technologies – “Digitalization”. It is responsible for the organization’s use of the opportunities that

open up in the process of developing information and digitalization trends.

In the opinion of the authors, such a representation of economic subjects is more complete and accurate, as it reflects their essence, based on the dependence of real economic results and digitalization trends of the modern economy.

The Analysis of digital technologies involvement in the development of the economy has shown an increase in almost all indicators in the evaluated development drivers.

1. Big data.

Big data market volume in 2018 amounted to 38 billion US dollars, in 2019 – 46 billion US dollars. According to experts' forecasts by 2025 it will amount to 132 billion US dollars. At the same time the world's digital data volume has already amounted to 33 zettabytes in 2018.

The drivers of development in this direction are the following:

- the increase in data transfer rate;
- the growth of media capacity;
- the reduce in the cost of data storage;
- the increase in cloud services availability;
- the launch of educational programs in big data processing [14];
- the spread of the Internet of things;
- the increase of open data amount.

2. Quantum technologies

The volume of the quantum computing market in 2018 amounted to 0.86 billion US dollars, in 2019 – 1.13 billion US dollars. According to experts' forecasts by 2025 it will amount to 5.85 billion U.S. dollars. The global quantum encryption market in 2017 was $285.7 billion.

The drivers of development in this direction are the following:

- the trend towards electronics miniaturization;
- the increase in the volume of unstructured data;
- the search for new ways to encrypt;
- the launch of educational programs in quantum computing;
- the need for the rapid and secure transfer of information.

3. Robotics and sensors

The global robotics market in 2018 was 48 billion US dollars, and in 2019 it was 57 billion US dollars. According to experts' forecasts by 2025 it will amount to 147 billion US dollars. Expenditures on robotic systems and drones in 2018 amounted to 95.9 billion US dollars.

- The drivers of development will be the following:
- the increase of requirements for production flexibility;
- the growth of demand for industrial robotics to modernize production;
- the growth of demand for service robots;
- the development of image recognition technologies;
- the development of sensor devices.

4. Artificial Intelligence and Neurotechnology

The global Artificial Intelligence market was $21 billion in 2018 and $29 billion in 2019. Experts predict that it will reach $191 billion by 2025. In 2018 the deep learning market amounted to USD 3.18 billion.

The drivers of development in this direction are the following:

- the need to increase the speed of business processes;
- the development of open artificial intelligence;
- the growth of investments in the development of neurotechnologies;
- the increase in need for unstructured data analysis;
- the ability to more accurate determine of consumers' emotional response to products and services.

5. New production technologies

The global computer engineering market was $1.98 billion in 2018 and $2.08 billion in 2019. According to experts' forecasts by 2025 it will amount to 2.79 billion US dollars. In 2017 the volume of the global smart production market amounted to 153.25 billion US dollars.

The drivers of development in this direction are the following:

- the increase in the availability of 3D printing;
- the democratization of computer engineering technologies;
- the need to reduce the time to bring new products to market;
- the increase in computer systems performance;
- the increase in demand for customized products.

6. Industrial Internet

The volume of the global industrial Internet market in 2018 amounted to 168 billion US dollars, in 2019 it will be 214 billion US dollars. According to experts by 2025 it will amount to 934 billion US dollars. By 2025 it will include 22 billion connected Internet of Things devices in the world.

The drivers of development in this direction are the following:

- the reduction in the cost of sensors;

- the standardization of industrial Internet technology;
- the distribution of 5G networks;
- the need to improve the security of unmanned vehicles;
- the increase in the number of connected devices;
- the development of energy-efficient long-range communication technologies.

7. Distributed Registry Systems (Blockchain)

The global blockchain market in 2018 amounted to $0.6 billion, and in 2019 to $1.0 billion. According to experts' forecasts, by 2025 it will amount to $28.3 billion. In May 2019, the market capitalization of the top 100 cryptocurrencies amounted to $250 billion, and the volume of daily transactions using Bitcoin is $10 billion.

The drivers of development in this direction are the following [15]:

- the need to provide an environment of trust between parties to digital transactions;
- the need for new tools to store and process large data;
- the increase in the number of non-cash payments;
- the dissemination of biometric identification technologies;
- the development of blockchain-based marketing;
- the need to increase the transparency of transactions.

8. Wireless communication technologies

The drivers of development in this direction are the following:

- the increase in the volume of data and the need for rapid data transfer;
- the spread of the Internet of Things and the industrial Internet;
- the growth in e-commerce;
- the development of unmanned transport;
- the demand of users for qualitatively new content;
- the need to increase network bandwidth due to increased traffic.

9. Virtual and Augmented Reality

The global market for virtual and augmented reality technologies amounted to $27 billion in 2018 and $44 billion in 2019. According to experts' forecasts by 2025 it will amount to $815 billion. In 2016 342.8 million people used augmented reality technologies in mobile phones.

The drivers of development in this direction are the following:

- the growth of indication systems demand;
- the growth of user requirements to the content received;
- the growth of demand for UX/UI design solutions;
- the development of global media content;
- the introduction of navigation sensors into smart phones;
- the search for new solutions to improve the quality of education, demand for immersive learning.

## V. Conclusion

In conclusion, it should be marked that the economic potential of digital technologies is enormous, thus all economic subjects face the challenge of creating the development-friendly environment for their capabilities and abilities in terms of digitalization. It can be achieved through the creation of individuals and legal entities-friendly infrastructure and institutions through the Internet and the promotion of digital entrepreneurship, which will require the benefit of a fairly wide range of stakeholders. According to the experts estimates a high-digitalization plan will lead to a global GDP growth of $1.7 trillion by 2025 in case of maximum concomitant effect. In this way, the digital economy will generate 24.3% of global GDP by 2025.

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