

The Interaction Between Innovative Technologies in the Course of the Institutionalization of the Digital Economy

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Abstract—The development of the digital economy is discussed as a complex institutional transformation. The authors link the stages of this transformation with the interaction between three types of innovative technologies. The first type includes production technologies. The second type includes both organizational technologies that correlate with changes in business models and technologies used in the provision of services. The third type includes humanities technologies that influence human consciousness. The article demonstrates how these technologies are transformed in the digital environment. It is shown that at the present stage of the institutionalization of the digital economy, humanities technologies aimed at helping people adapt to the new environment play the most important role. The provisions of the theory of institutional change, in particular the concept of the institutional market, are used to substantiate the typology of technologies proposed. It is proved that launching the institutional market mechanism will not only accelerate the institutionalization of the digital economy but also determine the set of technologies which will make both companies and entire countries competitive at present and in the future. The authors suggest that further studies could be carried out into how various types of innovative technologies interact in different industries and countries.

Keywords: *digital economy, technological change, institutional change, innovative technologies, humanities technologies*

I. INTRODUCTION

Current technological change in the field of digital technologies adds new characteristics to the way how economic systems function by creating new sources of economic growth. As reported by McKinsey, the digital economy accounted for 24% of Russia's total GDP growth in the period from 2011 to 2015. According to Russia's Higher School of Economics (HSE), by 2030 more than half of Russia's growth in GDP will result from digitalization. However, the institutionalization of the digital economy is extremely uneven, as evidenced by a wide range of values in the IMD World Digital Competitiveness Ranking as of 2018 (from 100 given to the USA to 24.795 given to Venezuela). In this ranking, Russia was given 65.207 points out of 100 and took only 15th place among 29 countries with populations greater than 20 million (a position behind Poland and Thailand) and 10th place among 30 countries with GDP per capita less than \$20,000 (a position behind Chile and Kazakhstan).

The data in the ranking are given for 63 countries and cover several different aspects. Among them are 1) the ability of a country to develop new technologies, which is connected with know-how (Russia took 24th place with 74.082), 2) the overall context that enables the development of digital technologies, which includes both the technologies existing today and government regulation (Russia ranked 43rd with 57.730 points), and 3) the level of preparedness to exploit digital transformation, which implies business agility and adaptive attitudes (Russia ranked 51st with

48.234 points). This wide range of values indicates that the institutionalization of the digital economy is influenced by both national policy and economic agents, such as companies and the public.

At present, digitalization is transforming the relations between economic agents not only in trade, construction, and transport industries but also in various sectors which are strategically vital for the development of the Russian economy [1]. Assuming that the digital transformation of the modern economy is a mixture of technological, organizational, and behavioural innovations, the authors set themselves the goal of identifying how all types of innovative technologies interact in today's world and how influential they are in the institutionalization of the digital economy.

II. MATERIALS AND METHODS

In the study, technology is considered in two aspects – firstly, as a set of operations aimed at turning materials and substances into products and services, and, secondly, as an analytical description of this process which sets the rules for converting resources into goods and services. The acceleration of technological development has led to an increase in the importance of technology as an object analysed by economists, which has found its reflection in the emergence of innovative concepts [2, 3, 4].

The development of the digital economy is interpreted as a stage of technological transformation which results in the need to transform production processes and models of interaction between economic agents [5] and the need to adapt to the new reality. The degree of change that has already happened makes it possible to analyse it from the perspective of the institutional approach [6]. Digital technologies are considered to be a foundation for innovative technologies that reflect various aspects of the institutionalization of the digital economy.

III. RESULTS

The mechanism of the institutional market plays a key role in today's digital transformation of the economy. Widespread use of innovative technologies, especially those supported by a digital foundation, can be achieved through this mechanism.

In order to trigger this mechanism, it is necessary to consistently disseminate innovative technologies of the three types which are different in terms of technological evolution:

- technologies for processing natural substances and creating predominantly material goods (technological innovations);
- organizational technologies that influence the interaction between the participants in the production process and aid the creation of products including both tangible and intangible ones (organizational innovations);

- humanities technologies that contribute to the creation of intangible benefits for adaptation to a changing world.

With constant growth in the rate of technological change and the digitalization of the economy, the role of technologies of the third type is becoming more prominent, influencing the opportunities for further institutionalization of the digital economy.

IV. DISCUSSION

A. *Innovations in the technologies of the industrial era in the context of the digitalization of the economy*

This type includes innovative technologies for processing natural substances and creating pre-dominantly material goods required to meet human needs. These technologies heavily rely on machinery and equipment, reflect the industrial era the most, and are closely linked with techno-logical innovations.

In the industrial economy, the influence of technology on economic performance depends on its ability to reduce costs per unit of production through the use of more advanced equipment [7]. In the context of digitalization, both capital costs and labour costs per unit of production decrease. This becomes a platform for unlimited technological growth and is corroborated by an al-most intermittent process of technological change. From a technological point of view, the control of machinery, equipment, and electronic devices is performed through algorithms that are developed by staff and followed by the systems of automation. The devices themselves form re-source pools [8] which are almost unlimitedly scalable and, if necessary, interact with each other without human intervention through "smart" technologies [9].

The Internet of Things (IoT) technologies supporting production processes are aimed at:

- improving product quality and production safety through computeraided control over compliance with technical standards, including those regarding the use of hazardous and harmful substances, and through eliminating the likelihood of using counterfeit parts [10];
- improving maintenance quality through more accurate projections of wear levels and equipment failure prediction [11];
- cutting operating costs through automated lighting and air conditioning systems [12], etc

B. *Innovations in organizational and service technologies in the context of the digitalization of the economy*

Over the past half-century, the area where different kinds of technology have been implemented has expanded significantly and gone beyond the production sector. Content analysis of Russian articles published from 2010 to 2018 has revealed groups of technologies and made it

possible to classify them depending on the object to which these technologies are applied (see the following table).

TABLE I. GROUPS OF TECHNOLOGIES CURRENTLY USED

№	Object	Technology
1	Production processes	manufacturing, mineral processing, welding, protection, clearing, freezing, stability improvement, processing and treatment, disposal, installation
2	Intellectual processes	design, creation, calculation, adaptation, modelling
3	Service processes	prospecting and exploration, maintenance, operation, support, transactions, distribution, cleaning services
4	Processes aimed at improving the quality of human capital	development, training, support, incentivization, selection and screening
5	Management processes	management, decision making, forecasting, selection, organization, quality control, accounting, monitoring, audit, analysis, evaluation and assessment, testing, standardization, cost reduction

^a Compiled by the authors.

As can be seen from above, the last four objects are associated with technologies that influence how participants in the process interact with one another. It means that the second type of innovative technologies covers both organizational technologies that define business models and management structures and service technologies that create tangible and intangible products. Technologies of the second type correspond with the post-industrial era and are associated with organizational technological innovations.

When such technologies are developed by companies outside the production sector, their functions become universal. If these functions, which are services in their essence, are outsourced to many different companies, it lays the groundwork for improving their quality through specialization and the division of labour [13]. These services, or functions, are represented by financial, logistics, prospecting and exploration [14], and oilfield [15] services, as well as many others whose main resources are intelligence and computer hardware and whose main product is new solutions offered to the market.

Among the examples of innovative technologies of the second type which contribute to the institutionalization of the digital economy are building information modelling (BIM) technologies, geographic information system (GIS) technologies, smart cities (oneM2M, Smart City), and railway traffic management systems (such as ERTMS). IoT technologies supporting service processes are aimed at:

- obtaining real-time market data [16];
- tracking the movement of goods and materials, monitoring system status, resources and stocks in real time, and managing supply chains [17];
- data integration and analytics, including data on the operation of connected devices [18], etc.

C. Humanities technologies as technologies for adapting to the digital economy

A summary of approaches existing today [19, 20] makes it possible to identify the most important trends concerning working conditions in the digital economy:

- change in the nature of labour as a result of its becoming more intellectual. This happens due to the emergence of more complex technologies and non-standard tasks, including those which stem from an increase in the variability of technology parameters as product and service life cycles are becoming shorter, as well as frequent changes in their technological characteristics;
- changes in labour management and the nature of labour productivity assessment, which are reflected in the absence of a direct correlation between labour hours and labour productivity against the background of a synergistic effect of teamwork performed by highly qualified personnel and knowledge which is inalienable from employees.

People can become adapted to a changing world through the use of humanities technologies, which are ways of influencing collective consciousness and organizing human thinking processes. Examples of humanities technologies include public relations, coaching, personnel management, branding, advertising technologies, and others.

In the context of the institutionalization of the digital economy, high technology in humanities can perform the function of a value system through working with public expectations as a whole [21] as well as improving digital literacy and digital skills, which are complementary to professional ones [22].

In the digital environment, the influence of high technology in humanities is increasing. Transparency of information makes the problem of its asymmetry less acute by facilitating the identification of consumers and suppliers of products and services, for example, when socially responsible companies disclose information about the results of their operations. Forms of marketing communications, including digital technologies (platforms, programs, services, etc.), channels (mass media, blogs, social networks, etc.) and tools (SMM, PPC, e-mail marketing, etc.) play an important role in shaping values and changing people's behavior.

D. The interaction between different types of technologies in the process of reaching institutional equilibrium in the digital economy

The typology of innovative technologies in the digital economy described above can be substantiated using the theory of institutional change [23]. Institutional imbalance, which takes the form of change in the cost-benefit ratio due to technological change, causes changes in the institutional environment. These changes are aimed at returning the economic system to a state of institutional equilibrium, which is now being reached at a different level.

In the context of the study, innovative technologies of the first type make it necessary for organizational structures corresponding to innovative technologies of the second type to adapt to new technological processes [24]. One such example is the emergence of networks connecting small service companies at the end of the 20th century and the beginning of the 21st century, as opposed to giant industrial corporations which formed in the 60s and the 70s of the 20th century [25].

The diffusion of technologies of the first and second types creates new ways and rules of meeting individual and production needs [26]. They correspond with potential institutional changes at the level of opportunities provided to both end users and companies as separate links in the production chain. Economic agents have a choice between different digital economy technologies.

Due to the fact that technology rapidly changes over the course of a generation, the public and businesses are not ready to adjust their routines and it becomes difficult to understand which of the technologies of the first and second types will be more competitive in the future. Innovative technologies of the third type can narrow the gap by solving two problems:

- cutting personal expenses on adapting to the new environment;
- guiding choices made by economic agents in accordance with the newly shaped values and restrictions, for example, the concepts of resource conservation or green consumption.

Ultimately, technologies of the third type should launch the mechanism of the institutional market, which will make the public and businesses select those innovative technologies which are the most convenient, leaving less convenient ones behind. The launch and operation of the institutional market mechanism will mean that institutional changes aimed at reaching institutional equilibrium at a new level of the development of the digital economy have become real.

V. CONCLUSIONS

Countries with market economies are currently experiencing downward movement in the Kondratieff cycle. Interest in technology in this period is, in a sense, connected with an interest in prognostication. If companies and entire countries are successful in analysing the technology structure of the digital economy, they will be the first to gain competitive advantages.

The interaction between the three types of innovative technologies discussed (technological, organizational, as well as technologies in humanities) has made it possible to characterize the process of institutionalization of a new type of economy, which is the digital economy. At the first stage, technological innovations trigger organizational changes necessary for making a transition to new business models.

This new reality necessitates changes in legislation and the directions of national policy, which triggers the

mechanisms of institutional change at the upper level. At the second stage, technologies in humanities become a priority; they make it possible to guide choices made by consumers and businesses through the institutional market towards digital solutions and models of behaviour.

A full-scale launch of the institutional market mechanism at the present stage of institutionalization of the digital economy will help to identify a set of its core technologies and predict further trends in the evolution of technologies of all three types.

The authors suppose that further research can be done into how the interaction between different types of innovative technologies is manifested in different industries in order to find ways to improve the competitiveness of companies in corresponding markets as well as to improve national policy in this area.

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