

The Role of Digital Infrastructure in the Digital Transformation of the Modern Russian Economy

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Abstract: *This paper explores some of the key theoretical-methodological foundations of the development of the digital economy based on modern information and communications (digital) infrastructure. In the present climate of globalization, no nation can adequately develop socially and economically without employing digital technology: the development in countries that ignore it is doomed to be imperfect. By interacting with each other and penetrating production, digital technologies ensure the dynamic development of the economy and society. Digital objects form digital infrastructure, which is the foundation of the digital economy. The authors prove that the digital economy model brings about the need for infrastructural reliability, required to ease and speed up the reproduction process. The paper substantiates the need for closer interaction between the scientific community, business sector, and government. It describes the role of knowledge, innovations market, and innovation growth areas from the perspective of the choice of priority areas for the development of the digital economy. The authors consider international organizational, scientific, technical, and technological forecasts and trends in the context of national development with a view to identifying the determinants of competitiveness and fostering competitive advantage for the Russian economy. The key focus is on ensuring economic growth based on the development of high-tech digital infrastructure.*

Index Terms: *digital economy, digital infrastructure, digital technology, digitization of the economy, risks.*

I. INTRODUCTION

The latest events in the economic and political arenas are a clear testimony to the failure of horizontal and vertical integration on a global scale, which has caused a loss of the ability to govern these systems, leading to chaos in the system of economic development [1], [2]. From an external factor in the system of governance potential uncertainty is being transformed into an internal one, providing large systems with new tools for managing and modeling the economic environment. However, in the conditions of insufficient feedback on the part of the national governance centers, this

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kind of administrative mechanism is forcing economic entities to seek out new ways to balance the development of the national economy by moving it out of the field of potential threats. Globalization processes, which in the late 20th and early 21st centuries covered virtually all spheres of socio-economic activity, have caused the emergence of new specific features, which may play a determining role in the economic development throughout the current century. In this context, this concerns the development of digital technology and its impact on the organizational, institutional, and essential characteristics of socio-economic activity. These processes affected the formation of the digital economy as a specific type of the economy, which may be defined as “an economic activity, in which a key factor of production is data in digital form, processing of large volumes of data and utilizing the results of their analysis, by contrast with traditional economic forms, significantly increasing the efficiency of various types of production processes, technology, and equipment and enhance processes related to the storage, sale, and delivery of goods and provision of services” [3]. The general foundations of the digital economy formation in today’s developing information society have been explored by prominent scholars D. Bell, A. Gallimore, P. Drucker, M. Castells, E. King, Y. Masuda, M. Porat, R. Reddick, T. Stonier, D. Tapscott, and others. The digital economy may be viewed as a network economy [4]. Most of the research in the area of the digital economy is devoted to the analysis of issues related to the development of digital technology. The digital economy facilitates the evolution of modern economic systems and the development of non-market regulatory mechanisms and network organizational structures. As a result, sectorless network economy emerges, which is based primarily on horizontal relationships. Another term for the phenomenon one may encounter in the literature today is “online economy”.

It may be worth highlighting the following factors that facilitate the formation and development of the digital economy:

- development and diffusion of Internet-based technology, which creates the technical conditions for the formation and expansion of the network economy;
- transfer into the electronic environment of the Internet of the various types of socio-economic activities, which is keenly promoted by many national and international organizations;

- transformation of traditional organizations into network establishments, which in practice means the active use of information technology, and reduction of the share of traditional hierarchical forms of management while increasing the share of collective ones;

- creation of network variants of “horizontal” economic structures focused on servicing the entire range of organizations within the economy (e.g., commercial and financial infrastructure, system of labor relations, legal system, etc.);

- modernization of labor relations via their network form (e.g., distance work relationships or telework) [5].

The digital economy ensures the sought-after level of manageability of large systems, such as systems of corporate management (e.g., ERP, MRP, and CRM), information security technology, franchising, etc. The digitization of the economy is governed by network effects, which are manifested in biological, technogenic, and social systems. It provides numerous positive effects for corporate establishments: increased organizational capital, positive scale effects from the use of digital technology, high levels of transparency, and ability to mitigate the effects of market failures to admissible limits within a network. These effects provide the digital form of organization with an edge over other forms. However, the same effects may also have disastrous consequences. This is due to the fact that modern corporate establishments operate in an environment where classic laws of economics either do not work anymore or work in a distorted manner. Moreover, these laws “may be compromised by pressure from lobbyists, which, in effect, invalidates their objectivity and compromises the sustainability of particular consistent patterns” [6]. At the same time, new digital laws and features of economic systems are emerging, which are manifested as part of alternative economic theories, more specifically the theory of the digital economy.

II. MATERIALS AND METHODS

A. Theory of the Digital Economy

The theory of the digital economy is distinguished by its universality. With the digital economy construed as a “collection of new technologies”, the theory is well capable of providing, in modern conditions, a new methodology for modeling and managing the economy under the influence of processes related to its informatizing and networking. Application of digital services by public and private institutions helps minimize transaction costs, i.e. expenditure on the movement of resources and goods. However, one can note a contradiction here too: reduced transaction costs may result in greater switching costs, i.e. organizational, time, financial, and psycho-emotional losses associated with the need to switch to a novel product or a new type of activity. In essence, this is a manifestation of the decline in the ability of economic entities to adapt to uncertain and dynamic environmental conditions. At the same time, it is also the formation of a new system of management at any scale, with high demand in the labor

market for specialists competent in risk management, which becomes its main parameter. One of the key objectives for a digital risk manager is to mitigate risk. In other words, priority activity for a risk manager is to manage the digital economy. However, network and integration processes, which typically facilitate the creation of hyper-systems, set risk managers a virtually unfulfillable task – forecasting risk for an establishment operating in various types of the business environment. To resolve the objectives of *risk* digitization, one employs cognitive maps, extensive software, as well as intellectual analysis.

Every day, digital technologies, in combination with high-tech communication channels, transmit immense volumes of information. The world community develops and implements numerous digital technologies of the varying degree of complexity. The Russian market for digital technology is just starting out at the moment. Throughout the world, research related to this sector is given special attention, with Russia seeking to find its niche in it too.

Digital technology is an aggregate of technological methods and techniques employed in the research, design, and production of materials, system devices, and high-tech products. It aims at administering purposeful control and management of the configuration and chemical composition of products and interrelationships between the elements that make them up, enhancing or supplementing the existing technical consumer-oriented characteristics, having a significant effect on the various spheres of the economy [7]. Digital technologies interact with many traditional and modern technologies. They are part of various key groups of technology designed to help resolve common global issues. This, above all, concerns cases when technologies are employed in resolving issues in the area of network management, energy development, greening, etc. Today, digital technology is becoming the answer to the ever-growing needs associated with the information-technological development of the progressive economy, which is grounded in creative knowledge. The evidence from international experience suggests that the development of the latest digital technology is influenced by the following factors:

- the current level and state of national policy in various spheres, including the scientific, technological, and innovation spheres;
- the current level of development of human potential, which characterizes the condition of the national education system and the workforce’s capacity to take part in the development and implementation of high technology;
- the current level of development of the regulatory framework and national programs regulating and guiding the enhancement of innovative activity by Russian economic entities;
- the current level of funding for the support of innovative systems on the part of the government, investors, and other financial establishments.

The assessment of digital potential is closely linked with the analysis of the conditions and restrictions impeding the development of the high-tech industry in Russia. The key factor limitations include the following:

- lack of funding and support on the part of the state;
- poorly developed regulatory framework;
- imperfect decomposition of innovation infrastructure, which leads to incoherence in the actions of business establishments;
- problems with business management and economic development, many of which are associated with a lack of stability and balance;
- insufficiently developed education system, which impedes the supply of qualified and competent graduates to the high-tech sector;
- average level of innovative activity and technological culture at industrial companies, especially regional;
- society's being informed insufficiently of the need and significance of developing the nation's high-tech industry and the degree of its effect on the quality of life;
- degradation of fixed assets used in regional high-tech production, which results in low product quality, making many of the products uncompetitive in the national and international markets [8].

To eliminate the aforementioned limitations, we focus our attention on the role of digital infrastructure in the digital development of the Russian economy.

B. The Theoretical-Methodological Aspect of Digital Infrastructure

Insight into the essence of infrastructure is provided by the comprehensive characterization of the means of labor provided by K. Marx in Chapter 7 of Volume 1 of his "Capital" [9]. The scholar identifies three major categories of the means of labor, which are as follows: (1) *mechanical* (machines and equipment – the "bones and muscles" of production), (2) *vascular* (e.g., pipes and storage tanks), and (3) *universal instruments*, which are required for the process to take place. Marx includes "among the instruments of labor, in addition to those things that are used for directly transferring labor to its subject, and which, therefore, in one way or another, serve as conductors of activity, all such objects as are necessary for carrying on the labor-process. These do not enter directly into the process, but without them, it is either impossible for it to take place at all, or possible only to a partial extent. ... Among instruments that are the result of previous labor and also belong to this class, we find workshops, canals, roads, and so forth" [10, p. 191]. We believe that the above characterization of the universal means of labor, without which the labor process either cannot take place at all or can take place only to a partial extent, is, actually, what may be viewed as a *methodological* approach to assessing the economic nature of infrastructure and its role in social development.

Thus, the *initial position* may be formulated as follows: the general conditions of production must be created for the process of material production to actually take place. As per the second position, *the spectrum of infrastructural facilities*

changes. This is the result of scientific-technical progress. If K. Marx spoke of roads back in his day, today we get to speak of information science, electrical power engineering, transportation, communications, public utilities, as well as education, healthcare, social security, etc. Today, it is NOT roads that resolve modern economic issues but *information*. Infrastructure must always be adequate to the technical level of primary production. We believe that the greater the level of development of digital infrastructure, the better the competitive position of the digital economy and its innovation potential [11].

The concept of digital infrastructure may be viewed as general conditions (foundation) for increasing the performance of the nation's government and business sector and ensuring decent conditions of people's daily life in the modern market economy. Digital infrastructure draws together all sectors of the market economy, facilitating its stable and balanced development. Digital infrastructure not only facilitates the increase in labor productivity and the creation of new jobs but also minimizes both production and transaction costs. This is crucial, as the cost of goods is reduced not so much because of the increase in labor productivity and so on but the increase in the *speed of information exchange*. Consequently, in an economy founded on the digital paradigm, a key factor for economic activity is electronic communication facilities, which, by contrast with traditional economic forms, significantly increase efficiency and quality in the area of production and consumption of goods, works, and services, as well as in the area of management procedures. Digital infrastructure facilities can help:

- 1) increase production potential;
 - 2) replicate the results from R&D and investment projects;
 - 3) expand the controlled markets, which makes it possible to minimize the costs of promoting new products into the market, as well as minimize transaction costs via a greater number of contracts and based on the ability to implement them better as a result of the pooling of assets;
 - 4) implement operations related to minimizing sales and distribution costs and increasing production as a result of the use of ancillary products, as well as:
- increasing the potential for the formation of systematic solutions;
 - providing a substantial improvement in overall management, with a focus on transforming it into strategic management;
 - allowing to enjoy the joint use of trademarks, brands, patents, and licenses and to exploit the extensive potential of franchising;
 - increasing the number of elements of information infrastructure in the form of new communication and telecommunication channels.

This significantly increases the mobility of resources and products both domestically and in the global market.



Consequently, there is an increase in the nation's export potential. Changes in the volume of its net exports may have a diverse effect on the size of national revenue the same way as fluctuations in various types of domestic expenditure. Even minor changes in the volume of exports may trigger major shifts in the levels of income, employment, and prices within the country. The various features of digital infrastructure may help resolve numerous pressing social and global issues by simplifying the interaction between the scientific community, business sector, government, and civil society. They increase productivity, creating new opportunities for business and labor activity,

helping some to get a decent education and others to continually enhance and expand their professional qualifications. Moreover, they help to meet the special needs of the socially disadvantaged, creating new opportunities for the socially significant research and mitigating the risks associated with climate change, food, water, and power shortage, etc. Digital infrastructure is a major driver of economic development, as it provides the information foundation for the progressive resolution of global issues, enhancement of managerial decision making, and stimulation of active participation of the business sector and civil society in improving the nation's economic well-being.

III. RESULTS

The digitization of the Russian economy is, essentially, a new reform of its economic mechanism. As rightly pointed out by Iu. M. Osipov [6], "Restructuring a country like Russia in any of the possible ways is a rather tall order, which has been attested by the experience of Soviet and Russian citizens over the last quarter of a century".

In this regard, this study has as its object the role of digital infrastructure in the digital economy. Today, the key objective for Russia is to develop, discuss, and adopt a specific strategy on creating so-called information (digital) infrastructure, which would be implemented based on the input from Russian companies and the nation's research and engineering institutions. Digital infrastructure may be viewed as a set of networks that bring together firms, people, and governments with the key focus computers, IP telephony, the Internet, as well as traditional media, such as television,

radio, etc.

The possibility of forming and further developing digital infrastructure is linked to the increase in the development of cooperation between legally independent participants in entrepreneurial activity and government authorities, or so-called public-private partnerships. A crucial form of collaboration predicated on joint action and aimed at resolving issues of strategic development of the national economy is emerging today [12]. In shifting to the digital economy, the state cannot select priorities optimally anymore. This is done by the markets at the level of territories in a mode of collaborative dialogue between the government, the scientific community, and the business sector, with a focus on switching to the vector of smart specialization [13], [14]. This is where the state takes on a new functional role – to facilitate continuous innovation-based prosperity based on the creation of information and communications infrastructure. It is important to understand that production and information and communications infrastructure must be commensurable, otherwise the economy will not be able to move forward. Russia's weak information and communications infrastructure augments business risks and constricts business horizons. It blocks innovation and diversification and undermines the mechanism of turning savings into long money, which has caused the nation to chronically trail behind the leading economies.

Russia possesses immense reserves and vast scientific-technical potential in the area of digital technology in terms of technological processes related to the development and replication of digital infrastructure with preset parameters – from the origination of an innovative idea through R&D to the implementation of R&D models in various spheres of the national economy [15].

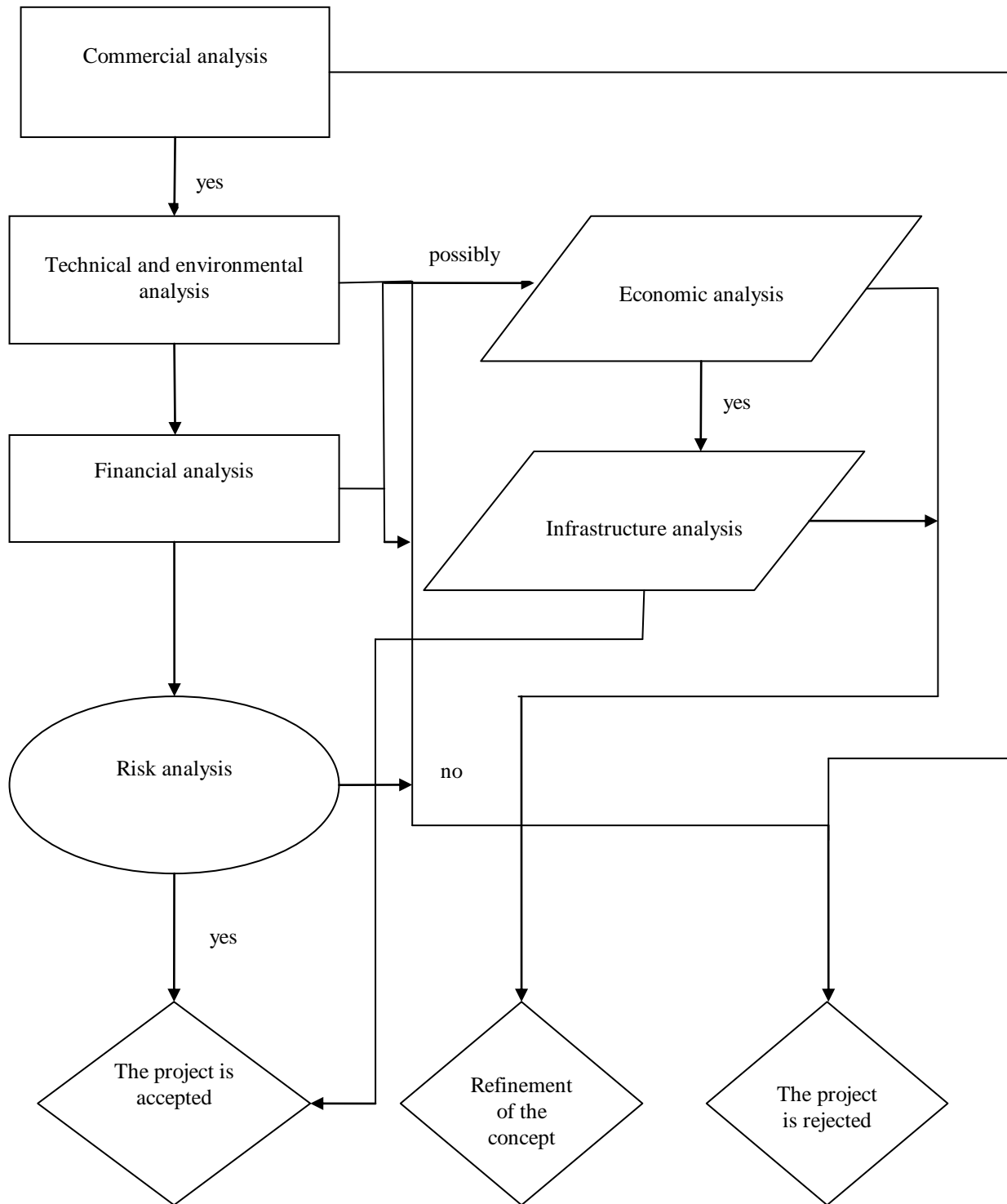


Fig. 1. An algorithm for the digital activity of Russian economic entities

On the one hand, a major characteristic of the Russian economy is the nation's considerable scientific-research potential, which is reflected in the availability of modern scientific-educational and research centers and laboratories at universities and industrial enterprises. On the other hand, the nation's existing potential has been used with *low efficiency* due to the insufficient activity of production establishments, lack of unity between them and science and education, and low levels of investment in the regional economy. To help overcome inertness in digital activity, we have developed an algorithm for business analysis of innovative activity that may help facilitate the enhancement

of the process of digitization of Russian economic entities (Fig. 1).

As evidenced by Fig. 1, the development and implementation of digital infrastructure in the operation of business establishments is a systematic objective. By following a scheme represented by this kind of algorithm for fostering the digital activity of Russian economic entities, with a focus on the development of R&D and implementation of high-tech solutions built on new knowledge, Russians may well witness the rapid development of a modern market economy in their

country, the formation of potential for economic growth, and improvement in their quality of life. The formation of digital infrastructure sets it apart into a specific area of engineering and economic knowledge. Consequently, the objective of preparing relevant engineering and managerial human resources may require putting together various nontraditional educational programs aligned with digital development.

IV. DISCUSSION

The “development of technological infrastructure and use of large databases have triggered a large-scale digital transformation of our society. Whilst the previous stage of the digitization process was characterized by an expansion of the Internet access for millions of consumers, the new stage is distinguished by the integration of a wide spectrum of digital services, products, and systems into a single cyber-physical system” [5].

Digital infrastructure is intended for the analysis of large volumes of data, provision of technological support for economic monitoring and forecasting, as well as decision-making. Major significance, in this regard, is attached to *infrastructure objectives*, the most significant of which is the objective of creating a single *information space*. This creates the groundwork for implementing global cyberspace. A properly organized *infrastructure* for collecting and processing large arrays of data in these sectors creates more favorable conditions for resolving key objectives of managing and organizing the effective operation of departments within the digital economy model. Currently, a number of leading nations are implementing an extensive set of special-purpose programs aimed at a comprehensive overhaul of information systems in alignment with the requirements set by concepts of development in the 21st century. A significant amount of attention is devoted to the digital infrastructure component, which helps ensure the required globality, continuity, and promptness of decision-making on information support. The analysis of the current condition of existing infrastructure information systems, both domestic and foreign, indicates that they mostly are narrowly specialized systems oriented at performing a limited number of functions: communication, monitoring, navigation, etc. However, the modern consumer of information needs an integrated infrastructural information system that provides a whole spectrum of information services based on the Internet principle.

Throughout the world, digital infrastructure is transforming the way people do business, producing and distributing new opportunities, optimizing and automating all kinds of processes. For instance, many countries are currently engaged in implementing a concept known as “connected republic” and are quite close to putting it into effect. In a republic of this kind, citizens can freely work and communicate with each other, overcoming bureaucracy. The functions of the connected republic go beyond the duties of traditional electronic public administration (e-government); it provides more effective ways to deliver government services. It laid the groundwork for a new kind of public

administration, where decisions are made not by government officials but by citizens themselves. In this context, the latest progressive concepts include “connected home” and “connected life”.

The concept of “digital city” is getting increasingly attractive today. It denotes a city that operates based on digital infrastructure. The Cisco Expo-2008 conference featured a book entitled “Digital Cities. Broadband Access and Intelligent Buildings: The Basics of Design and Construction”. The authors of the book explore a set of concepts, methods, and solutions related to creating a digital society based on broadband information networks and provide multiple examples of this type of ideas that were put into effect in real life. The book places information exchange on the basis of modern economics and suggests that only an information-based society may be regarded as truly developed today. A developed nation must be as informatized as possible, with the development of city infrastructure expected to culminate in an information city. The book talks about the possibility of developing information and communications networks that would work based on the IP-protocol. It examines a set of models for constructing networks of varying complexity and discusses a set of solutions in the area of telecommunications proposed by Cisco for major corporations. Cisco has taken an active part in the practical implementation of the “digital city” concept in different parts of the world. Russia has been slower than Western nations in terms of the development of digital infrastructure, although the nation has been quite instrumental in the development of fields such as e-government, digital authentication, digital telephony, digital television, etc. In the area of implementation of digital technology by companies, in the late 20th century, Russia significantly trailed behind the EU and some other developed nations, ranking just slightly ahead of Turkey, China, and Mexico [16].

For a region, having a formed digital infrastructure means being on the cutting edge side of things, having the potential for forging mutually beneficial domestic and international ties, as well as galvanized development. This type of work must be organized locally so as to harmonize activity at the federal level and ensure an individual approach in respect of each particular region, as all regions have their own distinctive characteristics and needs. Putting together regional programs on building digital infrastructure allows considering the interests of the business sector, i.e. each region will need to properly organize work with various public authorities. The components of national digital infrastructure provide the backbone for digital transformations of the nation’s economy and activities, a foundation for all kinds of digital solutions, services, and platforms. One of the key benefits offered by digital infrastructure is reduced transaction costs.

Digital infrastructure facilities may help significantly reduce expenditure on transactions, which includes costs associated with searching for information, i.e. information costs, carrying out negotiations and making decisions, and control over the fulfillment of contractual terms and obligations.

The greater the level of development of digital infrastructure, the better the competitive positions of the digital economy and the better its innovation potential. In the climate of uncertainty, sustainable growth can be achieved only based on the increase in innovation potential, both in terms of production and infrastructure. This is connected with the increase in public-private partnership activities, i.e. cooperation between legally independent participants in entrepreneurial activity and government authorities. What is emerging today is a crucial form of collaboration predicated on joint action aimed at resolving issues of strategic development of the national economy. Public-private partnerships may help to achieve multifold gains in the productivity of existing factors of production and serve as a key mechanism for deriving economic gain and achieving key objectives in terms of balancing out the economy in a climate of stiff global competition.

In shifting to a digital economy, the state cannot select priorities optimally anymore. This now is done by the markets at the level of territories in the mode of collaborative dialogue between the government, the scientific community, and the business sector, with a focus on switching to the vector of smart specialization. The state takes on a new functional role – to facilitate continuous innovation-based prosperity based on the creation of information and communications infrastructure.

No economic breakthrough can be possible without a sound foundation, i.e. without a high-tech information and communications infrastructure. It is important to understand that production and information and communications infrastructure must be commensurable, otherwise the economy will not be able to move forward. Russia's weak information and communications infrastructure augments business risks and constricts business horizons. It blocks innovation and diversification and undermines the mechanism of turning savings into long money. As evidenced by statistics, the nation has been characterized by sustained technological and sectoral simplification of the production structure, as well as chronic trailing behind the leading nations.

As a result, Russia's development has been of sync with world development. The problem is not the sanctions but the government's failure to comprehend the role of digital infrastructure in assimilating the new digital paradigm. The latest major documents (e.g., the concept on innovation clusters, programs for the innovation-driven development of state-owned companies, etc.) speak about increases in labor productivity, breakthrough in the raw materials and arms markets through the nation's own technological effort (based on forcing state-owned companies to purchase innovations from small businesses), entry into new export markets through global chains, creation of the nation's own import substitution chains in its own territory, and the issue of low

demand for breakthrough technology. The question arises: "How can one develop a digital economy without robust infrastructure?" Thus, a top-priority objective for the Russian government is to attract private investment into digital infrastructure projects for the purpose of improving the nation's information and communications environment.

Digital technologies are intended to serve as a boon to society, with a focus on putting in place a whole new material-technical base. The potential they offer is capable of altering the world ecosystem, triggering a revolution in the nation's medicine, industry, agriculture, politics, armed forces, etc. The most "revolutionary" phenomenon in the sphere of employment is so-called telework, or working from a virtual workplace [7]. A rationally constructed innovation strategy by the state aimed at the active stimulation of innovative activity may identify new and enhance existing competitive advantages associated with the scientific-technical potential of both the entire nation and its business sector. This should help overcome recurrent turbulence in economic development.

The identification and implementation of these priority areas will help galvanize the process of formation of the domestic market for innovations and provide for the nation's long-term strategic interests in the socio-economic sphere.

An economic model that is predicated on judicious domestic and international policies will help launch the mechanism of building a digital economy in Russia. Today, Russia's agenda for economic development includes the need to develop its digital economy with a view to driving the nation's scientific, technological, and demographic progress, ensuring its sovereignty and defense capability, and fostering social justice. Effective analytics can provide invaluable information on which business operations work flawlessly and which require improvement [17, 18].

In Russia, the problem is not the sanctions but the underestimation of the role of digital infrastructure in assimilating the new digital paradigm. Hence, a top-priority objective for the Russian government is to attract private investment into digital infrastructure projects for the purpose of improving the nation's information and communications environment. This is now increasingly voiced in media narratives. Russia, however, has yet to put in place a robust digital infrastructure that would facilitate a digital transformation of the national economy and other areas of the nation's activities.

V. CONCLUSION

1. Creating a competitive economic environment in Russia requires resolving the issue of forming a digital infrastructure that meets world standards. This may require increasing subsidies for R&D to develop the nation's information and communications infrastructure. This might be done using the continuous-flow innovation method.

The method may help to enhance the technology within the system of digital infrastructure, with a focus on continually improving its



quality, which should help increase activity in the entrepreneurial environment and drive economic growth on the whole.

2. The development of digital infrastructure helps to achieve innovation synergy among economic entities. Digital infrastructure can become the pole for the growth of the national economy. From this follows the fundamental rule of digital economics: stimulate the digitization of the economy through enhancing digital infrastructure. We believe that this may be considered a postulate of Russia's future economic policy.

3. The evidence from international practice suggests that achieving a sustainable increase in productivity requires not just digitalizing the economy but creating a network economy based on high-tech digital infrastructure, which must provide a multiplying effect on the entire economy.

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