The Evolution of Digital Capital in Organizations: A Quantitative Assessment

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Abstract: This study analyzed the evolution of resources in organizations towards digital capital using the example of Russia, by analyzing data on the development of technological infrastructure. It concluded that, over the past decade, there were moderately favourable conditions in terms of technological orientation in the Russian Federation. However, only a third of Russian organizations have mastered digital transformation in the context of digital interaction in the online environment using relatively simple information technologies. At the same time, a downward trend was noted for the pace of digitization of business processes and management decisions through dedicated software, reducing the global competitiveness of such organizations. The quantitative assessment of the evolution of digital resources demonstrated that Russian organizations have only a basic level of mastery of digital technologies, with some additional capabilities. This level is characterized by the use of relatively simple digital technologies and standard software. Thus, Russian economic entities in almost all areas use information and communication technology as a component of digital capital for the production of added value, but within limited professional competencies. The study results can be used by organizations' management for meso-level research and by policymakers for evaluating the digital economy.

Keywords: digital capital, ICT, knowledge economy, global information networks, digital resources

Introduction

The ubiquitous use of digital technologies in a chaotic business environment amid the COVID-19 crisis plays a key role in dealing with the aftermath of the pandemic. The measures introduced to contain the coronavirus infection (movement limitations, social distance, and

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wearing masks) required a new way of interaction from the business sector in the form of remote work and using digital platforms and technologies for video conferencing and going online. In this environment, information and communication technology (ICT) has helped alleviate the impacts of the pandemic, with uneven degrees of mitigation. This concerns, first of all, connectivity limitations (access, use, and speed), social inequalities, industrial heterogeneity, low organizational competitiveness, and limited access to data and information management, especially in developing countries (Bárcena, 2021; Romanyuk, Sukharnikova & Chekmareva, 2021).

However, as technology advances, new governance challenges constantly emerge: the importance of cybersecurity steadily increases (each innovation in technology carries the potential for new types of cyber threats); the business environment becomes more variable (technology introduction contributes to the update of economic relations and the structure of business models); environmental aspects of digitalization undergo changes (new digital devices, applications, and data transfers increase energy consumption, contribute to climate change, and generate large amounts of electronic waste) (UN, 2021). The transformation of organizations in terms of digitalization in Russia is of particular relevance today because, over the past decade, digital technology has evolved from the tactical level, focused on attracting consumers through enhanced access to information services, to the strategic level – the full-fledged formation of the digital economy (Romanyuk, Sukharnikova & Chekmareva, 2021; Abdimomynova, 2021).

The present study is divided into five parts. The next section introduced the concept of Digital Capital and provides the rationale for the study. There follows a short section on research methodology. A Results section describes the outcomes of the study and is followed by a discussion, where the collected findings are compared with those presented in other similar studies. A Conclusion summarizes the research findings, practical implications, and a description of further work directions.

Literature Review

The use of digital technology has now become global due to the mass distribution and availability of information in an online environment. This trend encourages organizations to undertake digital transformation to better their overall activity by means of improving the quality of service, optimizing internal operations, and creating business models suitable for the digital economy (Bárcena, 2021). In order to digitalize products, services, and business processes, organizations need to adopt the latest digital technologies, particularly software. With its help, every function (especially those related to marketing, customer service, human resource management, and production) will contribute to the comprehensive digital

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transformation of the organization (Khin & Ho, 2018). In view of this, combining technology with business, the available models will play a significant role in building a future digital ecosystem.

In the current environment, technological infrastructure and modern management embody the capital, resource, and management tools of the organization (Romanyuk, Sukharnikova & Chekmareva, 2021). Effective human interaction with technological environments was examined by Park (2017). He found that technology users can benefit greatly from a digital society through technology adoption and free access to it. In addition, Park introduced the concept of digital capital (DC) as a resource that can be used to obtain benefits for the individual, organization, or community that owns it. It is accumulated over time and can be mobilized to create added value. As such, DC exists in physical objects, like products or buildings, or in intangible forms, like knowledge or wisdom. In other words, it exists either in objectified forms that have material properties or as embodied states (Park, 2017).

During the "pre-digital" era, researchers distinguished between five types of capital or resources (5C): financial, natural, produced, social, and human. While not itself productive, financial capital promotes economic production through a system of ownership or control over physical capital. Natural capital is made up of the resources and ecosystem services of the natural world. Produced capital consists of physical assets generated by applying human productive activities to natural capital and capable of providing a flow of goods or services. Social capital, the most difficult to measure, includes such intangible concepts as shared values, socially significant knowledge, mutual understanding, and trust. Human capital refers to the productive capacities of an individual that can be inherited and acquired through education, training, and experience (Goodwin, 2003). Even though a wide range of data is available, to date, the question of the existence of human capital has not yet been finally resolved by researchers since, unlike others, this capital type is not alienable (Piketty, 2014).

In the digitalization era, a new, digital form of economic circulation has emerged. It presupposes that ideas, knowledge, labour, and rights to use seemingly idle assets are transferred between geographically dispersed but connected and interactive online communities. This dissemination is evident in a number of digital economic environments such as social media, online marketplaces, crowdsourcing, crowdfunding, and other manifestations of the sharing economy (Langley & Leyshon, 2017).

The widespread use of smartphones and digital platforms has led to a new type of digital power. At the micro-level, this digital power tends to rule the behaviour of actors and users of digital networks and is likely to turn the traces of their activities into Big Data networks. However, at the macro-level, the Big Data network, consisting of user behaviour traces, has

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become the third form of capital, which surpasses industrial and financial capital – the digital one. Today, a considerable number of companies linked to digital technologies and the Internet are making profits in ways ranging from simple sales of software and applications to direct dominance over large Big Data networks (Jiang, 2019). The rapid development of the Internet and emergence of novel digital solutions in the last two decades (e.g., cloud and mobile services, artificial intelligence) have increased the deep penetration of the Web in ICT and production, and made a notable contribution to shaping the Internet of Things community and developing a digital economy (Tou *et al.*, 2018).

Park (2017) defines DC as an ecosystem of digital technologies of an individual (organization, community) that shapes and guides the way a user interacts with digital solutions. DC embraces the preconditions for effective digital interaction necessary for an individual (organization, community) to thrive in a digital society (Park, 2017). According to Bughin & Manyika (2018), DC represents the resources underlying the key processes to developing new products and services for the digital economy. Traditionally, DC takes two forms. The first covers tangible assets (servers, routers, online shopping platforms, and basic Internet software) displayed as capital investments in the company's books. In turn, the second encompasses intangible assets that represent a significant and growing share of what drives today's digital economy (Bughin & Manyika, 2018).

DC is not separated from traditional 5C capital types. It allows them to be effectively used in the digital environment and contributes to their development, reproducing profit offline. DC transforms offline activities (shaped by 5C) into digital activities (time spent online, information and knowledge found, acquired resources and skills, types of activities performed) converted into externally visible social resources (better job, wages, knowledge; larger social network; and the like benefits). This new capital interacts with every single traditional capital type, and the fruits of this interaction have implications both for digital and social contexts (Ragnedda, 2018). According to Calderon Gomez (2020), cultural capital transforms into DC through the techno-socialization of people, whereas social capital changes into DC by dint of social practices and social support. DC can be retransformed into each of the three main capital forms: to an economic one by means of professional networking and access to goods; to a cultural one through access to knowledge; and into a social one by the differential management of social ties (Calderon Gomez, 2020). Perez, Sokolova & Konate (2020) managed to allocate a new capital type from DC called digital social capital (websites, social networks, etc.), which can influence financial capital through the cryptocurrency market and the rank of the initial coin offering according to the market capitalization.

Along with the rapid development of ICT, the traditional agricultural and industrial society is being replaced by post-industrialism and a new digital economy type. This economy is based

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upon knowledge and ICT and is characterized by the importance of acquiring and processing information for the sustainable development of the whole country and its competitive advantages (Digilina & Lebedeva, 2020). In our new knowledge-intensive society, the organization is likely to be grounded on networks through which information flows. Hence, high-tech manufacturing is organized around two groups that do not necessarily have any geographical proximity to each other. One of them is usually a highly skilled research and development centre with qualified personnel in a core industrial high-tech area. The other is most often represented by a large assembly facility with sufficiently qualified workers, but which could well be located on another continent and tightly linked to the innovation centre via global information networks (Jafari & Moharrami, 2019). The data above confirm that the transition to the digital economy is accompanied by the dramatic evolution of the role of economic resources. In industrial societies, the main drivers of economic development are largely represented by labour and financial resources, whereas, in digital economies, these are knowledge, people, and technologies (DC) (Popkova, 2019). Concurrently, unlike traditional types of resources (5C), which can be quantitatively measured, DC does not have direct quantitative characteristics and cannot be the object of complex quantitative analysis. The same applies to assessing the effectiveness of DC in the activities of organizations (Clermont, 2017).

As a process and result of gaining experience of using digital technologies in a digital environment by a business entity, DC can be viewed at several levels: the macro-level (characteristic of digitalization and digital transformation of the state), the meso-level (use of digital technologies by organizations), and the micro-level (as an individual characteristic). The state level concerns primarily demographic properties and characteristics of education, culture, and healthcare. For organizations, DC has value in the form of professional characteristics or digital competencies. In this context, digital resources make the organization more informatized primarily from the perspective of a technology management policy aimed at constructing and developing a telecommunications infrastructure that integrates geographically distributed production, material, and intellectual resources through a single information space. At the personal level, DC is represented by the accumulated experience of interaction in the digital environment, which is effectively used to generate income (Bannykh, 2020; Khitskov *et al.*, 2017).

A rather successful attempt to measure DC of an individual was undertaken by Ragnedda, Ruiu & Addeo (2020) through exploratory factor analysis and a representative sample survey of 868 residents of the United Kingdom. Researchers have developed a Digital Capital Index that shows linkages between DC and socio-economic and socio-demographic patterns such as age, income, educational background, and place of residence (Ragnedda, Ruiu & Addeo,

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2020). A similar methodology was used by Gladkova, Vartanova & Ragnedda (2020) in a study on the ethnic diversity of eight federal districts of Russia and their technological development. They surveyed 398 Internet users from the Russian Federation and used the Digital Capital Index comprising data on the level of digital access and digital competence. The results of this investigation showed the absence of a universal correlation between the ethnic composition of the regions and the level of their technological advancement. Lissitsa, Chachashvili-Bolotin & Bokek-Cohen (2017) have examined the digital divide between Israel's Jewish majority and two ethnic minorities: Israeli Arabs and immigrants from the former Soviet Union. They found that, beyond the impact of classic socio-demographic factors, DC is an essential resource contributing to the growth of income and professional prestige of people. Apart from this, DC was defined as a promising mobility channel for smaller ethnic groups in achieving social and economic equality with the ethnic majority in a country or region (Lissitsa, Chachashvili-Bolotin & Bokek-Cohen, 2017).

Exploring the specifics of building a digital economy, Benčič *et al.* (2019) came to the conclusion that, in developed states, the foundation of digital competitiveness of the economy is designated by the high level of integration of ICT and novel devices, while the barrier to the effective use of DC is the low interest of businesses in digital modernization. A diametrically opposite situation characterizes developing countries – their efforts to assure the integration of ICT and devices are far from satisfactory, but the interest in digital modernization from businesses is high (Benčič *et al.*, 2019). Adarov & Stehrer (2020) emphasize the critical importance of building an ICT infrastructure to ensure the required DC level and state that its effective use increases the competitiveness of both separate organizations and the whole country.

The review of academic sources on the matter has shown that previous works are mainly devoted to studying the DC of the individual, while resource evolution and quantitative assessment of DC formation in organizations are practically not touched upon. The Russian Federation, with its resource-dependent economy, attaches a special significance to the formation of the DC as the basis of the digital economy. Particularly, this evidence represents the reason for choosing Russia as a case study.

The scientific novelty of the study resides in estimating the contribution of meso-level digitalization in the digital economy based on standardized information on the implementation of digital technology as a ground for the diversification of the production system.

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The practical novelty of the study lies in the proposed marketing strategy aimed at transforming organizations through digital solutions relying on resources and capabilities in an ICT context.

The ultimate goal of this research is to investigate the evolution of resources of various organizations towards DC as the basis for economic activity, using the example of the Russian Federation.

The research objectives are as follows:

1) Analyze data characterizing the level of formation of the technological infrastructure of organizations in the Russian Federation over the past decade;
2) Monitor and evaluate the effectiveness of digital transformation in organizations of the Russian Federation;
3) Quantify the evolution of digital resources of organizations by means of economic dynamics modelling and a conceptual approach.

Materials and Methods

This study used a quantitative approach for two purposes: (1) to track the evolution of digital resources in the organization by analyzing the Federal State Statistics Service data (Rosstat, 2020) that reflect the formation of ICT as a component of the organization's DC (for 2009-2019); and (2) to demonstrate the results of the assessment through a conceptual model. The theoretical basis of this paper was represented by the works of Bughin & Manyika (2018), Khitskov *et al.* (2017), Bannykh (2020), and Romanyuk, Sukharnikova & Chekmareva (2021). The unit of analysis was the organization, and the selection criterion was organizations located on the territory of the Russian Federation. (This choice was based on the fact that this state strives to form a digital economy). Hence, an overview of the level of development of the digital economy in the country was provided by the example of Russian organizations.

The methodological tools used within this research were analysis, monitoring, quantitative assessment, and modelling. The visualization of the results was realized in the form of figures and tables.

The study process was divided into three stages.

The first stage presupposed the collection and analysis of indicators that characterize the technological infrastructure at the meso-level over the past decade on the basis of such data as:

1. Share of Russian organizations benefiting from:
    a) personal computers (PCs);
    b) server hardware;

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c) local area networks;
d) electronic mail;
e) global information networks.

2. Share of Russian organizations using global information networks (by type of economic activity);
3. Share of Russian organizations with a personal web page (by type of economic activity);

The preliminary analysis showed a positive trend in the development of technological infrastructure at the organization level over the past ten years, but with the restrained interest of businesses in digital modernization.

The second stage intended to monitor and evaluate the effectiveness of digital transformation in Russian organizations over the past ten years on the basis of the following data:

1. Share of Russian organizations using dedicated software;
2. Distribution of Russian organizations' expenses on ICT (by type);
3. Number of PCs in organizations.

Monitoring and assessment results showed that only one-third of Russian organizations mastered the specialized digital development level in terms of building digital interaction online, which does not assume the availability of professional competencies for making digital decisions based on engineering marketing knowledge.

In the third stage, a conceptual scheme for a quantitative assessment of the evolution of digital resources of an organization was modelled by aggregating weighted average growth data on individual ICT items (share of Russian organizations benefiting from PCs, server hardware, local area networks, electronic mail, global information networks, web pages; share of Russian organizations using dedicated software). In total, these data allowed an assessment of the current state of development of the organization's digital resources. To describe the conceptual model, three levels of digital development of the organization were used:

1. Basic – implies such a technological infrastructure of the organization, where workers do not require professional competencies based on engineering marketing knowledge;
2. Specialized – grounded on the technological orientation of the basic level and special capabilities of traditional digital technologies while referring to the readiness of the organization for digital interaction in the online environment;

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3. Advanced – assumes that business processes are automated using advanced digital technologies while relying on the technological infrastructure of the organization and special capabilities of digital technologies.

The result of the quantitative assessment showed that the factor responsible for the effectiveness of digital transformation on the part of business process automation in Russian organizations has a negative trend. This indicates that organizations of the Russian Federation are not able to make digital decisions that are based on knowledge of engineering marketing and can hardly be called competitive in the global market.

The research was limited to the ICT component of DC and made no assessment of such DC segments as human capital and knowledge. Future studies could fruitfully explore this issue further by their in-depth examination.

Results

In modern realities, the technological infrastructure of an organization reflects both the general evolution of information systems in DC and the technological implementations that are used to solve the everyday needs of the organization. The analysis of the technological infrastructure formed in Russian organizations over the past ten years (2009–2019) revealed that the portion of entities using server hardware in their activities grew to 54% (against 16% in 2009). Thus, the technologization increase at the meso-level was 38.0% or 3.8% per year, indicating restrained growth dynamics and relatively weak business interest in digital modernization.

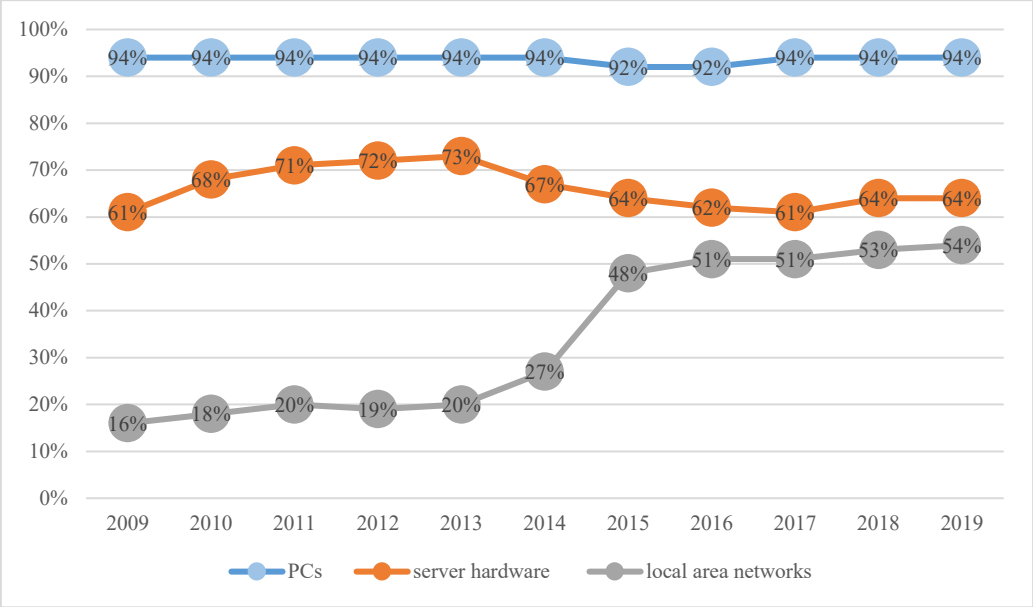

Figure 1. Share of organizations in the Russian Federation taking advantage of PCs, server hardware, and local area networks, for 2003-2019.

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020).

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As can be seen in Figure 1, 61% of organizations used local area networks in their activities in 2009. Their purposes were marked with great diversity: from creating a single network of service PCs in order to connect with the office equipment and access the Internet; to the performance of other more complex tasks, e.g., production automation and the use of customer relationship management (CRM), enterprise resource planning (ERP), and supply chain management (SCM) systems. In 2019, this indicator remained almost the same (64%). The rise in the share of organizations taking advantage of local area networks was 3% (from 61% in 2009 to 64% in 2019). This fact can be caused by difficulties with integrating several new systems simultaneously (like concurrent ICT introduction and Internet expansion).

Almost identical dynamics were observed for the transition of Russian organizations to digital business models based on the use of ICT, in which a particular role is assigned to electronic mail, global information networks, and personal web pages (Figure 2).

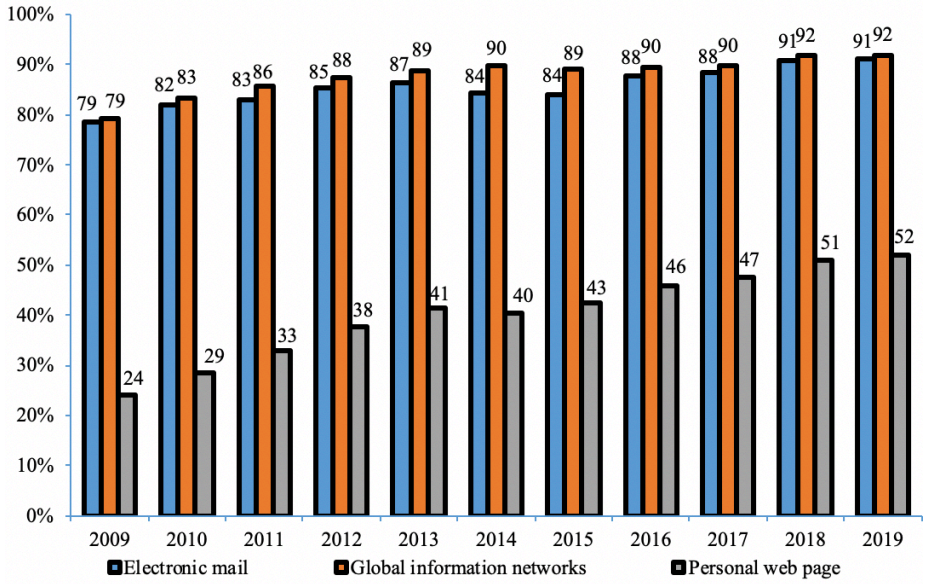

Figure 2. Share of organizations in the Russian Federation taking advantage of electronic mail, global information networks, and having personal web pages, for 2003-2019.

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020).

As seen in Figure 2, despite the frequent use of global information networks and e-mail services in their activities, only a little more than half of the Russian organizations (52%) had a web page in 2019. That is, 48% of companies, enterprises, and other entities and organizations were using traditional channels of communication with consumers, clients, sponsors, etc. Notwithstanding this, it should be noted that the demand of the information society and business sector for digital communication through the Internet was quite high during the investigated period (it increased by 28 percentage points, from 24% in 2009 to 52% in 2019).

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The outcomes of monitoring of the effectiveness of digital transformation by economic activity types in the Russian Federation and in terms of the use of global information networks and Internet web pages are presented in the Appendix (Tables A1 and A2). These data indicate that the largest proportions of organizations using global information networks in 2019 (96%) are in information and communication, finance and insurance, public administration and military and social security, and health and social services industries. The latter is also noticeable for active use of web pages simultaneously with the global information network (81%), which improves the effectiveness of such organizations in the external environment (Appendix, Table A2).

With increasing digitalization, the introduction of ICT is becoming a prerequisite for a successful organization's operation and development. The use of dedicated software can surely be called an important tool in the digital world, as it facilitates building the professional competencies of the staff to be able to make optimal digital solutions based on engineering marketing knowledge. Over the period from 2009 to 2019, though, the share of organizations in the Russian Federation utilizing dedicated software in their activities (not standard software supplied with a PC) decreased by 3%, from 89% to 86% (Table 1), which indicates the lack of stimulation for the information and technology sector development at the meso-level.

Table 1. Monitoring of the effectiveness of digital transformation in Russian organizations, for 2009-2019

Share of organizations using dedicated software	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
	%										
Total share of organizations using dedicated software	**89**	**89**	**90**	**86**	**85**	**86**	**85**	**85**	**84**	**86**	**86**
Software for organizational, managerial, and business tasks	61	60	60	60	60	56	52	53	52	55	55
Software for financial calculations	60	60	61	61	61	57	55	55	55	56	57
Other software	41	42	43	38	37	32	33	30	28	29	29
Software providing Internet access to databases	24	28	28	29	31	31	32	31	30	32	32
Software for automated production, technological processes	15	18	18	17	17	16	15	15	15	17	17
Educational software	17	19	19	22	18	15	14	14	14	17	16
Design software	11	12	12	12	12	12	11	11	11	13	13
Software for editorial and publishing activity	5	9	7	6	6	7	5	5	5	7	7
Research software	3	3	3	3	3	4	4	3	3	5	5

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Share of organizations using dedicated software	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
	%										
Legal reference software	56	54	55	57	55	54	52	52	51	53	53
ERP, CRM, SCM software	6	8	10	10	10	14	15	16	17	20	21
Procurement software	0	0	36	36	39	36	38	38	36	38	39
Sales software	0	0%	24	23	23	20	22	22	22	26	26

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020)

Note: "Other software" indicator covers systems for automated banking, trade, ordering, library management, translation, and other specialized tasks.

As of 2019, only 5% of dedicated software was used for scientific research and 7% for editorial and publishing activities. The largest portion of dedicated software users required special programs to conduct financial calculations (57%), to solve organizational, managerial, and business tasks (55%), and to access legal information (53%).

The development of ICT is reflected in organizational expenditures on providing the resource base (Figure 3). During the analyzed period, it reduced for almost all ICT types: telecommunication services and Internet access by 16%, purchase of software by 1.7%, ICT-related employee training by 0.9%, purchase of telecommunications equipment by 0.3%, other costs by 2.4%. The only exception was the cost of ICT services outsourcing and overall software purchase costs – the growth was 7.6% and 1.7%, respectively.

As shown in Figure 3, from 2009 to 2018, the distribution of organizations' costs for various types of ICT decreased by an average of 4.2% due to the rise in expenditures (by an average of 4.6%) on delegating internal ICT-related tasks to an outside contractor (to a greater degree) and purchasing standard software (to a lesser degree).

Overall, in 2019, most of the companies' ICT costs fell on the purchase of digital-related machinery and equipment, as well as their maintenance, modernization, and repairs performed by the organization's own resources (33.9%) and the purchase of standard software, with subsequent adaptation and adaptation to the organization's business model (21.1%) (Figure 4).

It is important to note that with the digitalization of the economy, the number of PCs in the organizations of the Russian Federation from 2009 to 2019 increased 1.5 times (from 8.744 million to 13.817 million PCs), and the number of PCs with access to global information networks rose 2.4 times. This fact testifies to the development of new technological trends and compliance with mandatory requirements of modern development and operation of organizations in the digital economy era (Figure 5).

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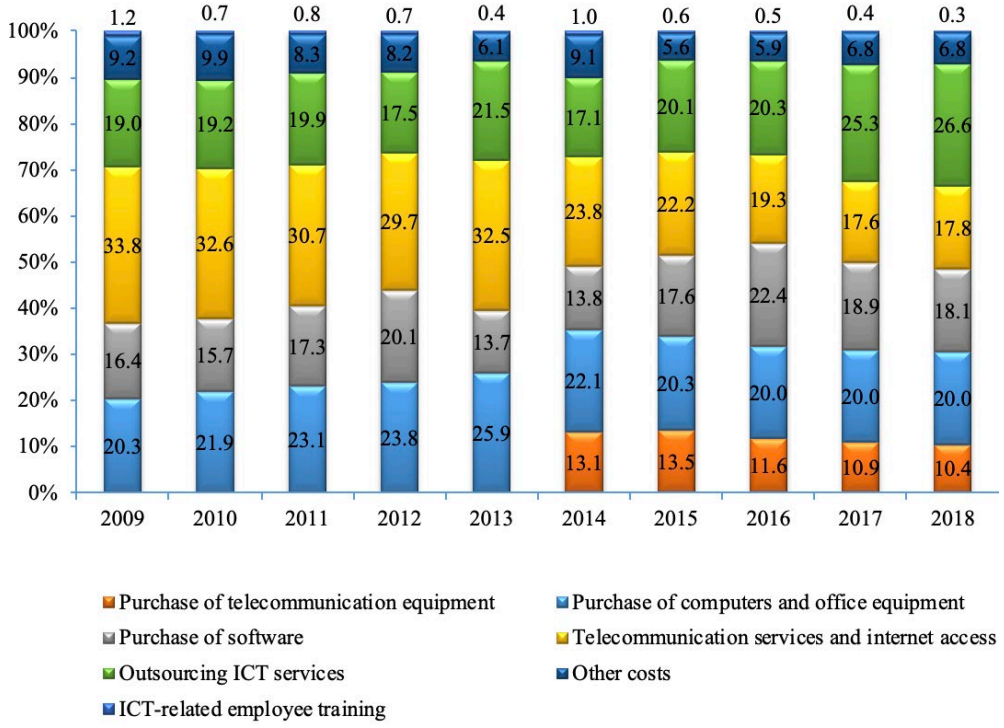

Figure 3. Distribution of Russian organizations' expenditures on ICT by type, for 2009-2018 (as % of total).

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020)

Note: The presented data cover the period until 2018 since this year, the Federal State Statistics Service revised cost allocation parameters to reflect changes more drastically. The distribution of ICT costs as of 2019 is shown in Figure 7.

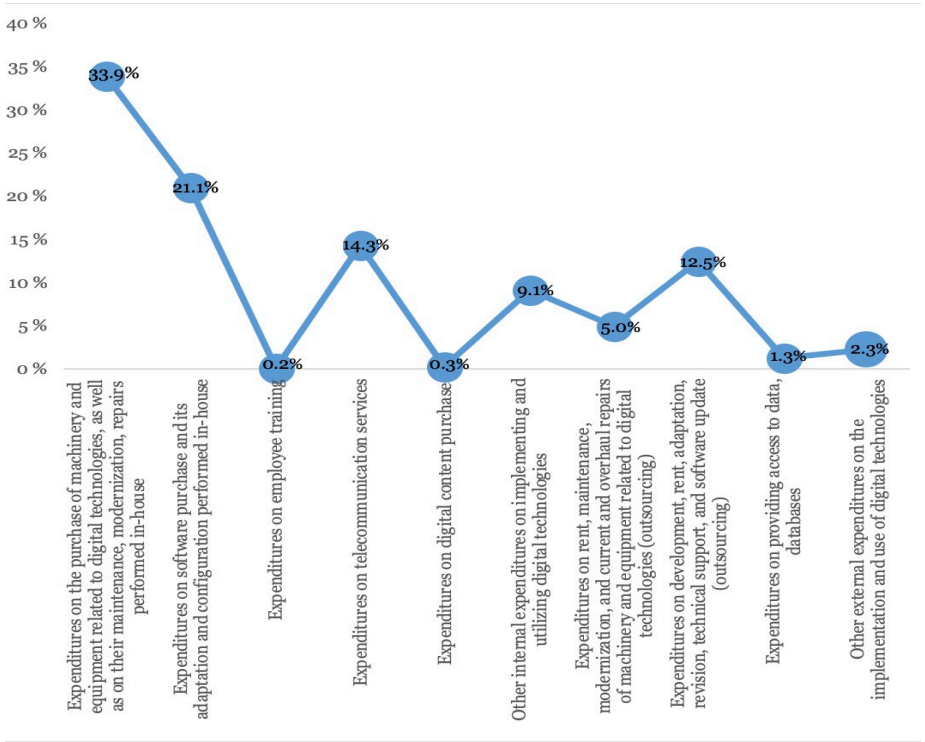

Figure 4. Distribution of Russian organizations' expenditures on ICT by type, for 2019 (as % of total).

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020).

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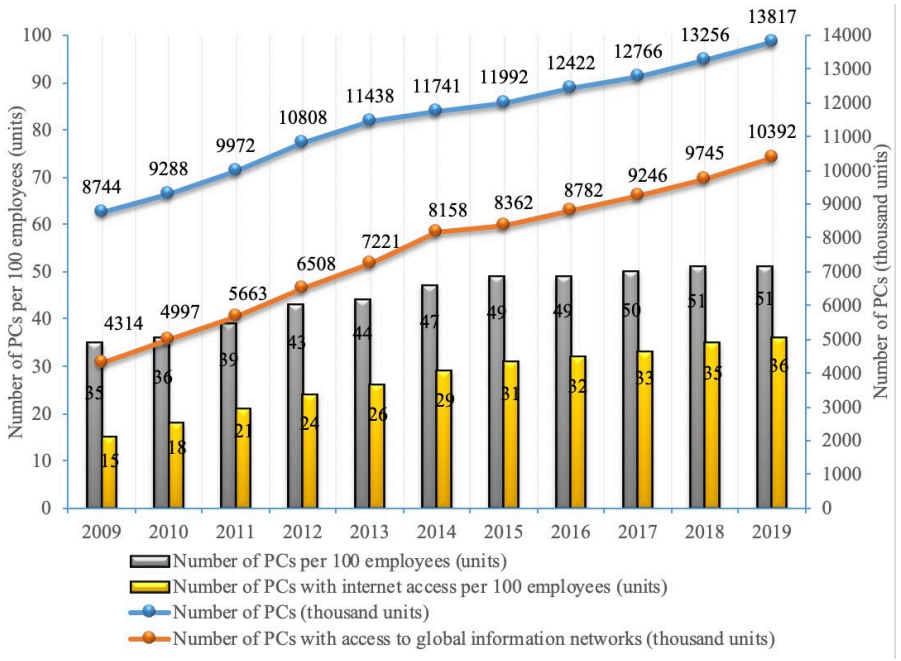

Figure 5. Number of PCs in the organizations of the Russian Federation, for 2009-2019.

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020).

As can be seen from Figure 5, the number of PCs per 100 employees grew with the saturation of companies with computer equipment. Similarly, the number of PCs with Internet access per 100 employees was noted to be in direct dependence on the number of PCs connected to global information networks.

Given the data obtained, one can conclude that the development of digital resources of organizations of the Russian Federation, regardless of the field of activity, use the following ICT components for the production of added value: computing equipment, server and telecommunications equipment, local and global information networks, new communication channels (electronic mail, web pages), and dedicated software. A quantitative assessment of the evolution of digital resources of Russian organizations in the context of economic dynamics modelling and conceptual approach is presented in Figure 6.

To describe the quantitative assessment of the evolution of the organization's digital resources in the context of economic dynamics (Figure 6), it is proposed to use three levels of organizational development:

- Basic level – describes the organization's technological infrastructure where workers do not require professional competencies based on engineering marketing knowledge;
- Specialized level – grounded on the technological orientation of the basic level and special capabilities of relatively simple digital technologies; it defines the readiness of the organization for digital communication in an online environment;

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- Advanced level – designates the automation of business processes using advanced digital technologies.

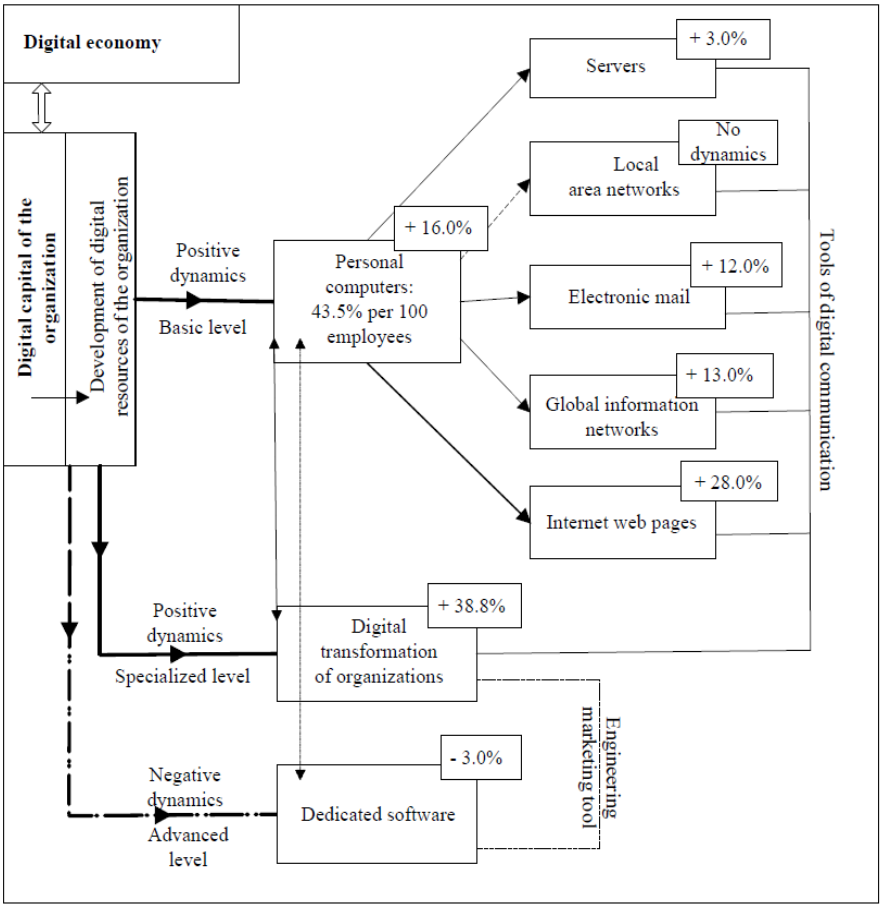

Figure 6. Conceptual model of a quantitative assessment of the evolution of organization's digital resources in the context of economic dynamics (on the example of the Russian Federation)

Note: *"⟺" unit of measure for the digital economy; "·····" negative dynamics; "⟶" organization's development level.*

Source: developed by the authors based on data from Rosstat (2020).

The result of the quantitative assessment based on the aggregation of data on the evolution of Russian organizations' digital resources over the past decade showed that the organizations have the basic level of digital transformation with a moderate technological orientation growth (+16%). At the same time, they mastered specialized capabilities using relatively simple digital technologies (+38.8%). The best results in terms of simple digital technologies were noted for the use of web pages (28%), global information networks (13%), and electronic mail (12%), with, however, rather negative dynamics of the use of advanced digital technologies, particularly, of dedicated software. Such a digital development progression suggests a gap in the DC of Russian organizations in the form of low interest in the modernization and automation of business processes, which does not allow them to follow the demands of the global market on the part of the business sector.

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Discussion

An organization's DC is based on a combination of knowledge and ICT, which complicates a comprehensive assessment of its level and impact on economic activity efficiency (Clermont 2017). Ragnedda, Ruiu & Addeo (2020), Gladkova, Vartanova & Ragnedda (2020), and Lissitsa, Chachashvili-Bolotin & Bokek-Cohen (2017) have analyzed DC through the prism of digital access and digital competence of individuals inhabiting one or another region but fail to assess the development of the ICT component of the DC in the corporate segment. In this regard, the present study is unique as it quantitatively assessed the formation of DC through the analysis of data characterizing the technological infrastructure at the meso-level and through monitoring the digital transformation in organizations. The examination of the development of technological infrastructure revealed the restrained growth of technological orientation in the organizations of Russia. Moreover, the dynamics associated with the use of ICT indicators showed that, in ICT development and DC formation, increased attention is paid to digital communication. In this respect, an increase in the number of organizations connected to global information networks, holding enough computer and server equipment, and having personal web pages was noted. The investigation outlined that the highest rates of using global information networks were recorded in public administration, military and social security, healthcare and social services, and higher vocational education. Aside from this, organizations operating in healthcare and social services, as well as in the field of higher vocational education, were defined as the first in terms of the number of personal web pages. This suggests a fairly high DC development degree in Russia at the level of the state (Bannykh, 2020). No less important is also the fact that internal and external costs for software procurement and adaptation are decreasing (their average share was 27.5% in the year 2019), and a growing share of organizations is now likely to outsource ICT services.

Similar to this research, Adarov & Stehrer (2020) studied productivity drivers at the meso- and macro-levels with a focus on capital accumulation and organizational structure. They deduced that ICT and intangible DC play a significant role in productivity growth. Ragnedda, Ruiu & Addeo (2020) characterize DC as the accumulation of digital competencies and digital technologies and argue that its development is related to the country's socio-economic and socio-demographic development patterns. The contribution of ICT to the economic performance of organizations was also confirmed by Bughin & Manyika (2018), who found that the spending on intangible assets (software, employees' training, and access to data and databases) has almost equalled with costs spent on tangible assets (computer and server equipment, their maintenance and repair) (Bughin & Manyika, 2018). In sum, the transition of the ICT component of DC to an immaterial state indicates a change in the role of economic

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resources used by organizations towards knowledge, people, and technologies, which is inherent to a developing digital economy (Popkova, 2019).

The findings obtained in the current paper are corroborated by those of Benčič *et al.* (2019). In particular, the statement that developing countries have a rather low digital modernization level was confirmed by the quantitative assessment results for 2019 – subdued technology-oriented growth in meso-level (1.6% per year), reduced spending on specialized software (-3%), and insufficient research (5%). Tou *et al.* (2018) argue that the intensification of the research and development sector creates new opportunities for global competition and compliance with the digital economy's demands. The results of building a conceptual model based on the evolution of digital resources of Russian organizations that link digital orientation and digital capabilities showed that the transformation of organizations in terms of digital orientation is moving towards digital stakeholder collaboration, while in terms of digital capabilities, there is a decline in outsourcing of engineering marketing tasks. In sum, the collected results demonstrate that Russian organizations have mastered the basic level of digital development using special capabilities of relatively simple digital technologies to interact and communicate in a digital environment while reducing the factors influencing the elaboration of digital solutions that organizations need to enter global markets.

Conclusions

Taken together, the findings of this work show that, over the past ten years, the development of technological orientation of Russian organizations in the field of ICT has evolved from the technologization of the working environment to full-fledged digitalization. The analysis of data characterizing the technological infrastructure and monitoring the use of ICT in Russian organizations revealed that only one-third of organizations, regardless of the field of activity, has a business model for the digital economy. Apart from this, it was found that the DC of the organization depends on the level of the development of its digital resources. The quantitative assessment of the evolution of the organization's digital resources in the context of economic dynamics and conceptual approach demonstrated that a growth trend is now present at only two levels of digital development: the one aimed at mastering basic technologies and the other implying the use of relatively simple digital technologies for interaction in the digital environment. Concurrently, it was noted that there is a negative tendency for the use of advanced digital technologies, in particular dedicated software. This indicates that the majority of Russian organizations experience difficulties in optimizing their business processes using digital technologies, taking a cost-saving approach to material and time resources, and improving the efficiency of strategic management and the quality of the output product/service due to low digital transformation rates. From this it follows that Russian

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organizations can hardly be deemed competitive in the globalized market. The country's central digital capital development focus is set on public administration, military and social security, health and social services, and higher vocational education.

The methods and results of this work can be exploited by the management of organizations in developing strategies, tactics, concepts, and programs for DC development in the digital economy. Besides, the present findings may have important implications for policymakers while analyzing the digital needs of organizations.

Further research is recommended to be concentrated on studying the current state of engineering marketing within the organizational structure of the Russian Federation.

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Appendix

Table A1. Monitoring of the use of the global information network by economic activity types in the Russian Federation, for 2009-2019

Economic activity type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mining	90%	91%	92%	91%	93%	94%	92%	93%	89%	86%	86%
Processing/manufacturing	92%	94%	94%	95%	95%	96%	96%	96%	95%	93%	93%
Construction	90%	92%	93%	92%	92%	92%	91%	91%	87%	84%	83%
Production and distribution of electrical power, gas, and water	73%	77%	82%	85%	87%	88%	88%	90%	92%	91%	94%
Wholesale and retail trade, auto repairs	84%	88%	89%	90%	92%	94%	95%	96%	94%	94%	93%
Hotels and catering services	73%	78%	81%	84%	85%	87%	87%	84%	86%	85%	87%
Transport and storage	87%	89%	89%	90%	90%	91%	88%	86%	92%	91%	92%
Information and communication	96%	95%	96%	96%	97%	97%	95%	95%	96%	95%	96%
Finance and insurance	93%	94%	95%	95%	95%	94%	92%	92%	92%	95%	96%
Real estate	75%	77%	79%	80%	80%	80%	77%	77%	63%	84%	86%
Research and development	94%	95%	95%	95%	95%	96%	95%	95%	95%	92%	92%
Public administration, military and social security	77%	85%	89%	91%	93%	94%	94%	96%	95%	95%	96%
Higher vocational education	96%	97%	98%	98%	98%	98%	96%	97%	97%	95%	95%
Healthcare and social services	90%	93%	95%	96%	97%	97%	96%	96%	95%	96%	96%
Recreation and entertainment, culture and sports	52%	57%	63%	70%	74%	79%	81%	82%	85%	86%	88%
Other activities	84%	89%	90%	92%	94%	94%	94%	93%	91%	91%	91%

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020)

Note: 1) green colour designates an increase in indicators, yellow marks years of stabilization, red denotes a decline; 2) "Other activities" embrace agriculture, forestry, hunting, fishing and fish farming, as well as other types of services.

Table A2 Monitoring of organizations in the Russian Federation having a personal web page, by type of economic activity, for 2009-2019

Economic activity type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mining	25%	28%	30%	33%	37%	35%	37%	41%	40%	37%	40%
Processing/manufacturing	46%	51%	53%	57%	58%	56%	58%	62%	64%	62%	63%
Construction	28%	31%	34%	37%	39%	37%	40%	41%	39%	38%	39%
Production and distribution of electrical power, gas, and water	17%	24%	29%	34%	36%	34%	39%	42%	48%	48%	51%
Wholesale and retail trade, auto repairs	29%	36%	36%	40%	44%	49%	53%	54%	53%	59%	55%
Hotels and catering services	25%	29%	32%	35%	37%	38%	42%	44%	45%	43%	46%
Transport and storage	27%	31%	32%	35%	37%	36%	37%	38%	37%	36%	38%
Information and communication	60%	63%	66%	65%	68%	64%	62%	61%	62%	60%	63%
Finance and insurance	52%	55%	57%	62%	63%	61%	62%	65%	67%	69%	69%

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Economic activity type	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Real estate	23%	26%	29%	31%	32%	30%	30%	32%	19%	32%	33%
Research and development	61%	64%	65%	68%	69%	64%	67%	69%	70%	67%	66%
Public administration, military and social security	19%	25%	31%	38%	42%	39%	41%	45%	47%	48%	52%
Higher vocational education	74%	77%	79%	83%	82%	77%	79%	81%	88%	83%	85%
Healthcare and social services	13%	18%	32%	41%	51%	53%	59%	65%	73%	75%	81%
Recreation and entertainment, culture and sports	13%	15%	19%	23%	27%	28%	32%	37%	42%	45%	50%
Other activities	7%	8%	11%	14%	17%	17%	17%	19%	20%	20%	23%

Source: developed by the authors based on data retrieved from the Federal State Statistics Service of the Russian Federation (2020)

Note: 1) green colour designates an increase in indicators, yellow marks years of stabilization, red denotes a decline; 2) "Other activities" embrace agriculture, forestry, hunting, fishing and fish farming, as well as other types of services.

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