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STRUCTURAL AND DYNAMIC ANALYSIS OF THE USE OF ICT IN RUSSIAN ORGANIZATIONS

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Abstract

The study is based on an integrated approach using clustered and neural network analysis. The article reveals the urgency of the problem to use ICT in Russian organizations as a functional element of economic activity that implements the requirements for environmental sustainability, human development, an increase of innovation activity. The analysis of the economic rationality of ICT use in Russian organizations includes two stages: structural and dynamic analysis. Cluster and neural network analysis in "SPSS Statistics" of statistical data of the Federal State Statistics Service of the Russian Federation allowed estimating the importance and agglomeration. Cluster analysis associated structural multidimensionality of the classification procedure of the ICT use, and a simulated neural network gave the opportunity to establish the importance of the ICT use indicators in Russian organizations. At the structural stage, using cluster and neural network analysis, the importance and agglomeration of the use of ICT indicators in Russian organizations are assessed. The dynamic stage includes the analysis of economic rationality of the ICT use in the clustering of Russian organizations by the dynamics of aggregated macroeconomic indicators. The number of employees is using personal computers and special software, indicators of ICT use in the country. The need to use ICT in Russian organizations is caused by the requirements of Industry 4.0 and the fifth technological mode. The high economic rationality of the use of ICT in Russian organizations is connected with activity in the field of information and communication.

Keywords: Cluster analysis, innovation activity, ICT, neural network analysis, Russian organizations.

1. Introduction

The digital world forms new criteria for competitive advantages of organizations, shifting the focus to the active use of information and communication technologies (ICT) (Smirnov, Semenov et al., 2019). The use of computer systems in the industrial, economic, household, social and management spheres has given rise to a fashionable topic of the digital revolution in changing world economic patterns (Smirnov, Osipov et al., 2019).

ICT are processes, methods of search, collection, storage, processing, providing, and information dissemination and ways of implementing such processes and methods (Federal law of 27.07.2006, No 149-FL); techniques and methods of applying computer technology when performing the functions of collection, storage, processing, transfer and use of data (GOST 34.003-90.); resources required for the collection, processing, storage and information dissemination (International Standard ISO/IEC 38500: 2008). ICT covers all the resources needed to manage information, especially the computers, software, and networks needed to create, store, manage, transmit, and search for information.

2. Problem Statement

The active ICT use in Russian organizations began with the development strategy of the information society of purpose which is: creating conditions to form a knowledge society through developing human potential; ensuring the security of citizens and the state; increasing the role of Russia in the global humanitarian and cultural space; developing the free, sustainable and safe interaction of citizens and organizations, government authorities of the Russian Federation, local government authorities; increasing the efficiency of public control, economic and social sphere development; forming of the digital economy (Decree of the President of the Russian Federation of 05.09.2017, No 203).

3. Research Questions

The problem to use ICT in Russian organizations is considered not only in the format of economic activity, role, and importance in the production process but also in connection with the requirements for environmental sustainability and human development (Gouvea et al., 2017; Hendon et al., 2017). ICT is an important factor influencing economic growth and innovation activity. The influence of ICT on economic growth can be divided into two main channels. First, the direct contribution of investment to ICT stimulates the combined growth of the economy and secondary production. Second, the indirect influence of ICT on the overall growth of the factor productivity in sectors that use and produce ICT (Erumban & Das, 2016).

4. Purpose of the Study

The research subject is the rationality of the use of ICT in Russian organizations. The research topic is the structural and dynamic analysis of the use of ICT in Russian organizations. The work aim was to identify the types of economic activities of Russian organizations with high economic rationality of using ICT.

5. Research Methods

5.1. Organization of the information flows

ICT is the main tool that allows organizing information flows at the pre-investment stage of the project, which helps responsible executives to reach effective solutions that simultaneously achieve the maximum total effect on a number of target parameters (Erumban & Das, 2016).

In China, the continuous spread of ICT has a growing impact on the production process and energy consumption. Replacement of ICT inputs contributes to the reduction of energy consumption in production (Zhou et al., 2018), including through the introduction of technological foresight (science, technology, and innovation activity) (Li et al., 2017).

In Russia, one of the decrease factors of the diffusion rate of new technologies in the field of energy-saving and alternative energy is the weakness of ICT.

Industry 4.0, which makes extensive use of advanced ICTs, continues on the path to system deployment of an upgraded power system to manage ever-increasing energy demand (Faheem et al., 2018). Rational implementation of Industry 4.0 requirements is possible with appropriate knowledge in the field of ICT (Han & Sohn, 2016; Lee et al., 2019; Amendola et al., 2018) and motivation (Lee et al., 2015; Malaquias et al., 2016; Yu et al., 2017).

5.2. Structural and dynamic analysis

Structural and dynamic analysis of the use of ICT in Russian organizations includes two stages. The first stage assesses structural importance and agglomeration. The second stage includes the analysis of the dynamics of the ICT use in clustering of Russian organizations.

Cluster analysis displays features of multidimensionality in the classification procedure of phenomena (objects) (Wu et al., 2018). The clustering process and the result depends on the method chosen and how the distance measure is determined. The study applies a hierarchical method of cluster analysis, the essence of which is to consistently combine smaller clusters into larger ones. Hierarchical agglomerative methods are characterized by a consistent combination of the initial elements and a corresponding decrease in the number of clusters.

The computational neural network in "SPSS Statistics" will make it possible to establish the importance of the indicators of the use of ICT in Russian organizations. A neural network is a set of analytical methods implemented on hypothetical learning principles that allow predicting the values of variables in some observations from the data of others. A neural network is used when the exact type of connections between inputs and outputs is unknown.

6. Findings

6.1. Cluster and neural network analysis

Cluster and neural network analysis of the use of ICT in organizations according to "Russian Classification of Economic Activities", RCEA. The results of cluster and neural network analysis of Russian organizations (RCEA 2010-2016), using "SPSS Statistics" on the basis of data from the Federal

State Statistics Service, revealed that the following ones are considered structurally active on the application of:

1) personal computers:

▪ cluster (minimum value, "squared Euclidean distance" < 3) – "Food production included beverages and tobacco" and "Manufacture of other non-metallic mineral products"; "Metallurgical production and finished metal products" and "Manufacture of machinery and equipment"; "Pulp and paper production; publishing and printing" and "Health care and social services"; "Food production included beverages and tobacco" and "Pulp and paper production; publishing and printing"; "Communication" and "Higher vocational education";

▪ importance (maximum value, importance > 90%) - "Production of coke and petroleum products" and "Financial activities";

▪ cluster (minimum value, "squared Euclidean distance" < 3) - "Manufacture of rubber and plastic products" and "Health care and social services"; "Food production included beverages and tobacco" and "Metallurgical production and finished metal products";

▪ importance (maximum value, importance > 90%) - "Financial activities";

▪ cluster (minimum value, "squared Euclidean distance" < 8) - "Mining operations, except fuel and energy";

▪ importance (maximum value, importance > 90%) – "Metallurgical production and finished metal products", "Production of coke and petroleum products "and "Building and Construction".

Structurally active in the use of ICT (RCEA 2010-2016) are: "Health care and social services", "Metallurgical production and finished metal products", "Production of coke and petroleum products", "Food production included beverages and tobacco", "Building and Construction", "Financial activities" and "Pulp and paper production; publishing and printing".

RCEA data 2017 on the use of ICT in organizations show that structurally active "Higher Education", "Activities in the field of information and communication", "Activities in the field of health care and social services", "Government administration and military security; social security". Cluster analysis of organizations by RCEA 2017, using PC, Internet and Web site revealed active "Mining operations", "Building and Construction", "Manufacturing activity", "Activities in the field of information and communication", "Hotels activities and catering arrangement".

6.2. Dynamics of the use of ICT

The dynamics analysis of the ICT use in active structural clustering of Russian organizations is the difficulty of its holding – the lack of consolidated statistics on income resulting from the ICT of the Russian organizations. To compensate for this shortcoming, we apply aggregative macro-indicators on the number of employees using PCs, the use of special software and the dynamics of using ICT indicators in the country.

6.2.1. Dynamics of organizations, with the share of the number of employees using the PC

Dynamics of organizations with the number of employees, using the PC, allows you to highlight a change in the framework of the mathematical error in organizations of 10-29 and 50-69 people (figure 1).
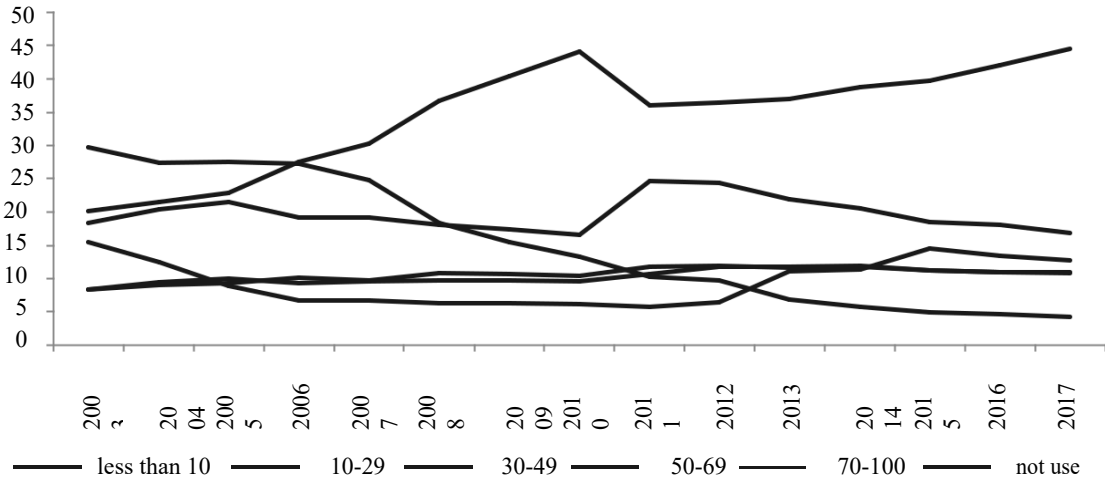
Figure 01. Organizations with a specific gravity of employees using PCs, 2003–2017 *Source:* according to the Federal State Statistics Service. Retrieved from http://gks.ru

Organizations with 70-100 employees demonstrate growth in the number of employees using PCs, while the decline is less than 10 people. It should be noted that in 2017 organizations that do not use PCs on the level of 2003.

6.2.2. Dynamics of organizations using special software

The dynamics of organizations using special software, allows you to allocate the stability of the program to solve organizational, managerial and economic problems; to manage the procurement of goods (works, services); to manage the sales of goods (works, services); for designing (figure 2&3).
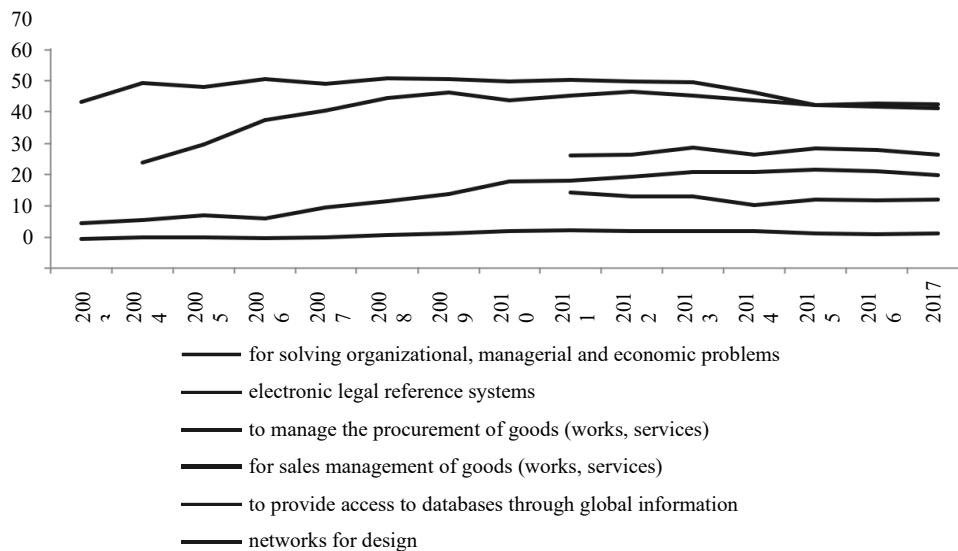

Figure 02. Organizations using special software tools, 2003-2017
Source: according to the Federal State Statistics Service. Retrieved from http://gks.ru
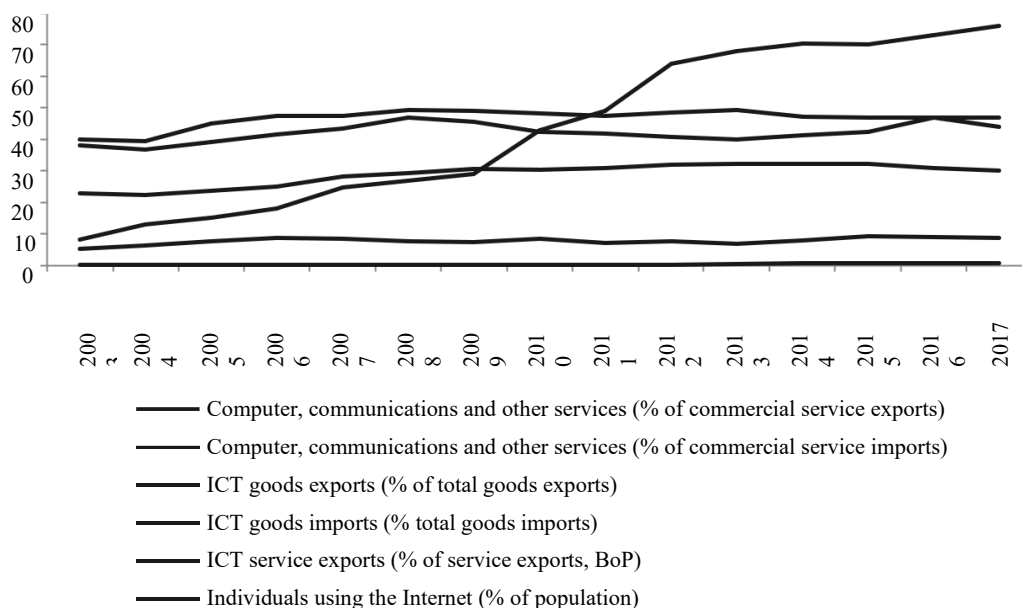
Figure 03. Dynamics of indicators using ICT in the country, 2000-2017
Source: built according to the data from World Development Indicators. Retrieved from:
http://gks.ru, http://databank.worldbank.orgThe electronic reference and legal systems and programs for
providing access to databases through global ICT see a slight increase.

6.3. Summary analysis of the use of ICT dynamics

Not a significant increase, within the limits of mathematical error, is noted: "Computer, communications and other services (% of commercial service exports)"; "Computer, communications and other services (% of commercial service imports)"; "ICT goods exports (% of total goods exports)"; "ICT goods imports (% total goods imports)"; "ICT service exports (% of service exports, BoP)".

Consequently, Russian organizations are stable in terms of the use of ICT. The rate of "Individuals using the Internet (%of population)" significantly increased in the post-crisis 2009.

A summary analysis of the ICT use dynamics (the organisation that employs 70-100 people with the active use of electronic reference and legal systems, and programs to access granting to databases through a global information network), the indicator "Individuals using the Internet", allows to conclude that high economic rationality possessed by the organization closest to the kind of activity "Activity in the field of information and communications".

7. Conclusion

The need to use ICT in Russian organizations has become a fully formed fifth world economic order, a characteristic feature of which is the strengthening of the expansion of capital. As a consequence of the numerous uses of ICT, the digital revolution has intensified this expansion. To maintain their competitive advantages, Russian organizations need to actively use ICT.

The use of ICT provides necessary, timely and relevant information as inseparable results for management decision making within separate management processes. The use of ICT reveals a variety of opportunities in the field of information collection and monitoring of the organization's activities (Zrakova et al., 2017).

Organizations experiencing competitive pressure should fully use ICT in economic activities (Singh & Teng, 2016). The use of ICT increases opportunities for technological modernization of the enterprises which seek to develop technological potential and to pass to innovations (Bernat & Karabag, 2018). At the same time, with the development of technological possibilities, it becomes possible to implement larger projects (Alami, 2016; Kagan, 2016; Kumar & Mallick, 2018), identifying and eliminating problems in the work of the organization and minimizing losses (Astuti et al., 2017).

The need to use ICT in Russian organizations is not only due to the internal needs of the organizations themselves, but also the state policy of the development of the digital economy, in accordance with the development strategy of the information society, the main purpose of which is to create conditions for the formation of a knowledge society.

Cluster analysis of the use of ICT in Russian organizations according to the RCEA 2010 – 2016 and RCEA 2017 revealed structurally active – "Building and Construction"; "Health care and social services" (RCEA 2010 – 2016); "Activities in the field of health care and social services" (RCEA 2017); "Activities in the field of information and communication".

Summary structural and dynamic analysis of the use of ICT, taking into account aggregated macro indicators (number of employees using PCs and special software, ICT use indicators in the country) revealed high economic rationality of the use of ICT in Russian organizations closest to the type of activity "Activities in the field of information and communication".

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