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The leading role of digital technologies in the creation of knowledge

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Abstract This paper focuses on the allocation of digital technologies by the leaders who have the maximum positive impact on processes of generation of the new knowledge in the conditions of the digital economy. Our research is conducted on the basis of the tools of the institutional economic theory.
We define the influence of digital technologies on the processes of generation of the new knowledge. Moreover, we develop a quantitative index of interrelation between the effectiveness of generation of new knowledge and digital resources – the so-called "Level of Leadership of Digital Technologies". Our indicator represents the quantitative index that characterizes the level of influence of digital technologies on the processes of the creation and generation of the new knowledge. Using our indicator, we distinguished the "digital leading technologies" as the key factor leading to the increase in the efficiency of the creation of the new knowledge.
Our conclusions demonstrate that use of the principles and ideas of institutional modelling of processes of generation of knowledge in the smart cites allows forming full predictive models of efficiency of generation of the new knowledge in these smart cities in the conditions of the digital economy.

1 Introduction

The post-industrial era we live in nowadays is characterized by the active development of the electronic environment and transition to the information civilization (Ziemba 2013; Abrhám and Wang 2015; Tkachenko et al. 2019). With regard to this, most of the developed countries in the world pay considerable attention to the development of the digital economy (Indjikian and Siegel 2005; Abrhám et al. 2015; Zielińska 2016; or Veselovsky et al. 2018).
The so-called “digital economy” accumulates different types of economic activity in which the use of digital data plays a role as the key factor of production, modern information networks, infrastructure for the data exchange, as well as the effective application of information and communication technologies. In general, it acts as an important driving force of accumulation of effectiveness and efficiency of functioning of the national economy, and also as a means of the optimization of its structure.
Digital economy is ubiquitous nowadays when all of us are dependent of the instant flow of data and information, posts, updates and likes on the social networks as well as other digital footprint we leave as we move through our daily lives (Akhter 2017). Digitalization can now be seen everywhere – from science and technology to business and finances. Take the high-frequency trading, for example. The stock market trading

is now done by algorithms that operate in milliseconds and nanoseconds and this trend is raising. It has been estimated that at the leading stock exchanges (e.g. Wall Street in New York), from 50% to 60% of trade is done by algorithms rather than humans (Korajczyk and Murphy 2018).
One of the first researchers stating that in the previous industrial stage of development of the public relations, direct human work was a decisive source of obtaining the surplus value, and in the following phase, that is a post-industrial society, the concept of "economy of knowledge" would take its place was Bell (1999). Moreover, the surplus value joins mainly information processes and their processing as well as the scientific knowledge (Sharma and Blomstermo 2003).
Some researchers claim that the term "Digital Economy" was coined in 1995 by the Professor Negroponte of the University of Massachusetts (Peters 2004). Quite often, this term is understood as a wide range of social, economic, production and technological processes and the phenomena, the general for which is the use of relevant innovative digital technologies (Chaplin 2018).
Moreover, digital technologies have the huge potential for improvement and acceleration of a set of various processes, therefore, indicators of investments which go for acquisition and development of the digital capacity of the company can become a key factor of its competitiveness in various spheres of the economy (Chaibai et al. 2014; or Popov et al. 2016).
However, questions of institutional modelling of the digital leading technologies stimulating processes of generation of knowledge did not find the necessary consideration in modern economic researches.
The main focus of this paper is the allocation of digital technologies as the leading trends having the maximum positive impact on processes of generation of new knowledge in the conditions of the digital economy on the basis of the paradigms of the institutional economic theory.

2 Methodology and the model

For the purpose of the assessment of the impact of processes of the digital economy on processes of generation of knowledge the industrial enterprises which are carrying out research activity and turning out hi-tech products, a series of interviews with heads of the representatives of the top and average management were conducted in the city of Yekaterinburg, Russian Federation. Our sample was a representative one covering managers from various industries.

In addition to the interview, we were able to obtain the data of the enterprises. During the interviewing the following dependencies were checked:

- whether there is a correlation interrelation between a dynamic number of users of digital technologies and the dynamics of the received results of the intellectual activity;
- whether there is an increment of the use of digital technologies that leads to increase in results of intellectual activity;
- whether different types of digital technologies differently influence the increment of various types of intellectual activity.

For the allocation of digital leading technologies, we introduce an indicator of the level of digital leadership in processes of generation of knowledge which can be presented as and calculated in accordance with the following formula:

$$LLij = dKi/dRdj \tag{1}$$

where:

LLdij - is the level of digital leadership at the generation of i-go like knowledge when using j-go like a digital resource.
dKi - is gain of i-ro like knowledge;
dRdj - is gain of j-go of a digital resource.

As appears from a formula (1) that if $LLdij > 1$, an increase in the usage of a digital technology by 1% leads to the change of effectiveness of intellectual activity by more than for 1%. This activity directed to obtaining new results of intellectual activity on purpose on the generation of knowledge, constructed such in the way is considered effective.

If, on the other hand, $LLdij<0$, then it means that a habit or a hobby of using the digital technology leads to a reduction of effectiveness of the intellectual activity directed to the generation of new knowledge. Thus, the level of digital leadership in processes of generation of knowledge represented by the quantitative

index that characterizes the gain from the effectiveness of generation of knowledge. Our results demonstrate that this index increases with and from the use of digital technology by about 1%.

3 Results and discussion

Our empirical research that included the assessment of the impact of digital technologies on the effectiveness of intellectual activity for the purpose of obtaining new knowledge yielded the following correlation communications results. It appears that there is a correlation between the variable describing the data on the use of digital technologies and the one describing the dynamics of obtaining results of the intellectual activity directed to obtaining new knowledge. The results of the conducted research are presented in Table 1 that follows.

Table 1. Correlation dependences and the level of digital leadership

Digital technology (x)	**Result of intellectual activity (y)**			
	New created products		**New created technologies**	
	Correlation coefficient	Digital Leadership	Correlation coefficient	Digital Leadership
Computers	0,909	5,28	0,948	4,77
Data storage	0,828	3,315	0,818	3,181
Corporate networks	0,776	0,931	0,787	1,71
Networks of the general access	0,60	0,729	0,561	1,07
Internet access	0,33	0,308	0,414	0,309
High-speed Internet access	0,081	-0,114	0,14	-0,211

Source: Own results

On the basis of the analysis of the data provided in the Table 1, we created three working hypotheses of the existence and interrelation of digital technologies as a result of the intellectual activity directed at the generation of new knowledge. All of them were confirmed, namely:

- there is a correlation interrelation between a dynamic number of users of digital technologies and dynamics of the received results of intellectual activity;
- increment of the use of digital technologies leads to increase in results of intellectual activity;
- different types of digital technologies differently influence the increment of various types of intellectual activity.

The largest level of digital leadership in the processes of generation of knowledge from the applied digital technologies is rendered by such digital technology as the use of computers. According to results of the conducted research, increase in use of such digital leading technology as computers lead to the growth of effectiveness of the intellectual activity directed to the development of newly created products for 5.28% and technologies for 4.77%. According our results, it is connected with the fact that computers, especially the latest models, allows increasing considerably calculations, processes of modelling, development and creation of new products and technologies, considerably reducing at the same time use of other resources, for example, of work, in processes of generation of new knowledge.

The second most important digital leading technology allowing to increase the effectiveness of the intellectual activity directed to the generation of newly created products and technologies is the introduction of storages of data at the hi-tech enterprises. At the same time, the level of digital leadership in processes of generation of knowledge from this applied digital technology as the use of storages of data, is one and a half times lower, than when using computers. This fact is explained by the fact that storages of data also, as well as computers participate in processes of generation of knowledge and carry out a role of storages and massifs on the processing of big data that accelerates and reduces the price of processes of generation of new knowledge at the industrial enterprises.

The use of such digital leading technologies named in our research as "Computers" and "Storages of data" seems to be the driver of development in the processes of generation of the hi-tech enterprises in the conditions of digital economy. At the same time, these digital leading technologies have property of the universality which means that they are equally important for all types and types of knowledge.

Moreover, our results show that such digital technologies as "Corporate networks" and "Networks of the general access" are not digital leading technologies anymore. On this very basis, it is possible to derive the calculated coefficients of correlation that these digital technologies have much more communication by

the effectiveness of the intellectual activity directed to the generation of new knowledge that the digital leading technologies considered above.

On the other hand, it seems that an increasing usage of such digital resources as high-speed access to the Internet in the organizations might cause the reduction of effectiveness in the processes of generation of knowledge. Application of this digital resource allows to increase only the data transmission rate in/from the organization, but it does not help to influence the processes on the generation of knowledge. In addition, in a number of cases the availability of the broadband Internet at a given workplace leads the increasing usage of fast Internet connection for the personal reasons of the employees which reduces the effectiveness of the processes of generation of knowledge as a result.

From the analysis of above-mentioned results and outcomes, it is possible to draw a conclusion that in general the organizations prefer to use digital resources only for acceleration of carrying out calculations or data storage. Other forms of usage might be inferior and undesirable.

4 Conclusions and implications

Our research set up a goal of studying the allocation of the digital leading technologies having the maximum positive impact on processes of generation of new knowledge in the conditions of digital economy. Our analysis was conducted on the basis of identification of interrelation between effectiveness of the intellectual activity directed to generation of new knowledge and digital technologies received the following theoretical and practical results.

First, for allocation of digital leading technologies the indicator of a quantitative assessment of efficiency of generation of new knowledge in the conditions of the digital economy – "the level of digital leadership in processes of generation of knowledge" was offered. The designed indicator, the level of digital leadership in processes of generation of knowledge, actually represents the quantitative index characterizing gain of the effectiveness of generation of knowledge at an increase in the use of digital technology by 1%.

Secondly, we performed the correlation analysis which allowed us to allocate the digital leading technologies having the greatest impact on the effectiveness of the intellectual activity directed to the generation of knowledge. Our results demonstrated that such types of digital technologies as "Computers" and "Storages of data" are actually the digital leading technologies and yielded steady interrelation with such types of results of the intellectual activity directed to the generation of the new knowledge as "Newly created technologies" and "Newly created products". In addition, such types of digital technologies as "Use of the Internet" and "High-speed Internet access" seem not to be connected and having any impact on the effectiveness of the intellectual activity directed at the generation of the new knowledge by the hi-tech industrial enterprises. Therefore, it can be concluded that the use of computers and data storage technologies increases the efficiency of processes of generation of knowledge. In addition, it turns out that the use of the Internet by the industrial enterprises does not influence the processes of generation of knowledge.

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