Smart cities: knowledge generation effectiveness in the digital economy

Popov Evgeny
Ural Federal University, Institute of Economics,
Ural Branch of the Russian Academy of Sciences
Ekaterinburg, Russia
epopov@mail.ru

Strielkowski Wadim
Prague Business School
Prague, Czech Republic
strielkowski@cantab.net

Vlasov Maxim
Ural Federal University, Institute of Economics,
Ural Branch of the Russian Academy of Sciences,
Ekaterinburg, Russia
Mvlassov@mail.ru

***Abstract* — The aim of the present study is to develop a set of tools for quantifying the effectiveness of knowledge generation in the digital economy by identifying the relationship between the effectiveness of new knowledge generation and the digital resources on which it is based. In the study, the relationship between the knowledge generation effectiveness and the digital resources of a smart city under the conditions of the digital economy was identified. In the article, it was offered concepts of "digital speed" as an indicator for the quantitative assessment of the effectiveness of knowledge generation in the digital economy. In the article, the conclusion was drawn that the principles and ideas of institutional modelling of knowledge generation processes can be used to construct fully-fledged models for predicting knowledge generation effectiveness in smart cities under the conditions of the digital economy. The theoretical significance of the study consists in the development of a set of tools for quantifying the effectiveness of knowledge generation in the digital economy. The practical significance of the study comprises the development of directions for supporting management decisions aimed at increasing the efficiency of knowledge generation in the digital economy.**

Keywords* — *knowledge management, institutional theory, modelling, innovation, typology, efficiency, forecasting, economic development.

I. INTRODUCTION

A smart city comprises an innovative urban centre that uses information and communication technologies alongside other resources for improving quality of life and the efficiency of municipal activities in such a way that the needs of existing and future generations are consistent with economic, social, environmental and cultural development.

As a consequence of the means by which they are promulgated, smart cities constitute a global phenomenon; nevertheless, different interdependencies are associated with their manifestation at the global level (Dameri, et al., 2019).

According to Francesco Paolo Appio, Marcos Lima and Sotirios Paroutis, Smart Urban Initiatives are spreading all around the world at a phenomenal pace. The bold ambition of such initiatives is to increase the competitiveness of local communities through innovation, at the same time as increasing the quality of life for its citizens through better social services and a cleaner environment (Appio, et al., 2019).

According to Vahid Baradaran, Sorour Farokhi and Zahra Ahamdi, the transition to electronically-intermediated smart cities under the ever more rapid digitisation of society is inevitable under modern conditions due to population growth and the transformation of human relations (Baradaran, et al., 2018).

The use of digital technologies by state and municipal governments has led to the emergence of new doctrines of urban development and the development of modern urbanised areas. One of the most significant developments in the use of digital technologies to support social progress is the concept of the "Smart City". The Smart City concept comprises an innovative doctrine in which the use of information and communication technologies combined with the intellectual potential of a territory ensures the formation of a stable link between the individual and knowledge, allowing the needs of contemporary and future generations to be addressed.

Constructed on the basis of technological innovation, smart cities are complex ecosystems that have the potential to improve the quality of urban life of the population by increasing processability and sustainability through a network of people, processes and data.

The Smart City concept is an increasingly popular topic in urban development discourses, evoking both excitement and scepticism. However, despite increasing enthusiasm for a such a refinement of the urban environment, the concept is still viewed as somewhat evasive. In her recent article, Maja Nilssen develops a typology of smart urban initiatives based on the degree and types of innovations they include informed by a discussion of existing contributions on urban smartness in scientific and innovative literature. In his opinion, the typology of innovation and relevant new knowledge should be structured as a smart urban continuum, including four dimensions of innovation: (1) technological, (2)

organisational, (3) collaborative, (4) experimental (Nilssen, 2019).

In order to analyse the efficiency of knowledge generation processes in a smart city under the conditions of the digital economy, it is necessary to develop tools for modelling these processes. At the present developmental stage of economic science, the most universal methodological apparatus for quantitatively modelling the efficiency of a smart city's knowledge generation processes in terms of digital technologies is that presented by institutional theory.

In their recent study, Dmitry Novikov and Mikhail Belov point out that it is precisely complex human activity that comprises the fundamental element of any economy, including digital. In connection with the aforementioned development of methodological aspects, the development of methods for modelling the digital economy constitutes an acute and pressing task (Novikov and Belov, 2019).

However, issues affecting the institutional modelling of the quantitative assessment of knowledge generation processes in a smart city have yet to be fully addressed in contemporary economic research.

Therefore, the purpose of the present study is to develop a set of tools for quantifying the effectiveness of knowledge generation in the digital economy based on an identification of the relationship between knowledge generation effectiveness and available digital resources.

Having fundamentally changed the rules for doing business, the development of the digital economy has also profoundly affected the daily life of human beings, providing unparalleled services and amenities (Watanabe et al., 2018).

Under contemporary conditions, the transition to a digital economy, implying the extensive use of digital technologies in all sectors of the economy, is occurring rapidly. As observed by Eric Ansong and Richard Boateng in their empirical study, it is precisely in the digital economy that the majority of new enterprises and jobs are to be found (Ansong and Boateng, 2019).

According to Negrea et al., at the present stage of economic relations it is the development of the digital economy and the digitisation of all information used by companies and various authorities that constitutes the main driver of the knowledge economy in general and the construction of a smart society in particular (Negrea et al., 2019). In this connection, it is precisely digital resources that become the primary source for the creation of social value (Todoruț and Tselentis, 2018).

According to Daniel Nepelski, digital technologies have the potential to modernise the global economy. Digital innovations based on new knowledge allow many problems to be solved: increased profits from the use of data, the heterogeneity of digital innovation actors and the ecosystem, digital skills in the entrepreneurial culture, financing for increasing the scale of new participants, technological compatibility and the protection of intellectual property. Thus, it is digital innovations based on new knowledge that form the basis for obtaining the benefits of digital technologies at all levels of management, including when planning regional development and smart city initiatives (Nepelski, 2019).

It should also be noted that a number of authors consider digital relations as comprising entirely new economic institution, having its own distinct norms and mechanisms (Geliskhanov and Yudina, 2018).

The main task of a smart city is to develop mechanisms for the introduction of information and communication solutions aimed at ensuring a higher standard of living for the population of the city (Raven et al., 2019). In this situation, a smart city is described by the following indicators: smart management, smart ecology, smart economy and the mobility of the city's population (Dudzeviciute et al., 2017).

Smart cities should establish a trend for sustainable development and a high standard of living for the city's population, using information and digital technologies to monitor and control the use of resources (Kobayashi et al., 2017).

In their 2019 study, Zaheer Allam and Zaynah Dhunny conclude that cities are increasingly turning to specialised technologies to solve social, ecological, morphological and many other kinds of problems. Although the developing concept of Smart Cities is highly encouraging of this perspective, the only way smart cities can stimulate the development of economic growth is by stimulating intellectual capital and increasing the efficiency of knowledge generation (Allam and Dhunny, 2019).

Two decades of research on smart cities was presented by Sepasgozar et al. in terms of the universal desire to develop new technologies and a new quality of life, but without taking local cultural differences into account. The smart cities of the future are faced by several key challenges. In the first place, it is necessary to make a choice of culturally appropriate technologies from the vast array of such technologies available globally. The second challenge consists in how to institutionalise such technologies, while the third is to manage their application (Sepasgozar et al., 2019).

In the recent article by Camboim et al., the leading elements that make a city smarter are identified on the basis of existing literature, interviews with experts and experiences of smart city projects carried out in Amsterdam, Barcelona, Lisbon, Vienna. The results show that a smart city consists in an urban innovation ecosystem based on the generation of new knowledge, considering interaction and cooperation among various stakeholders, who are provided with a flexible institutional structure and integrated participating management model to meet the needs of a digital ecologically-sustainable infrastructure and functional urban design having diverse amenities and facilities. The authors conclude that it is the new knowledge generated by the corresponding institutional structures that makes the city smarter (Camboim et al., 2019).

In a 2019 article published by Ismagilova et al., the notion of a smart city comprising a knowledge-based urban development approach is confirmed by research carried out in cities where new knowledge generated by human subjects results in an advanced development of the quality and living conditions of the population. In their view, the primary knowledge generation resource in a smart city consists in the availability of digital and information and communication technologies (Ismagilova et al., 2019).

According to Herscovici, the economic concept of the smart city lacks a range of sequential criteria for evaluating its

effectiveness, especially in terms of the innovation development processes taking place under its aegis (Herscovici, 2018).

Smart cities comprise complex ecosystems having interconnected systems or "systems of systems". Due to the large number of stakeholders, the diversity of application areas, the heterogeneity of data sources and the complexity of smart systems themselves, issues in the management of smart cities become very acute. Despite this, there are very few studies aimed at analysing the effectiveness of smart cities in the world literature; moreover, there are no quantitative evaluations of the use of digital economy solutions in smart cities (Hefnawy et al., 2018).

The theoretical analysis carried out by the present authors on the generation of knowledge within the smart city paradigm in the digital economy led to the following conclusions.

First of all, smart cities are almost unanimously recognised by researchers from all over the world as one of the main current directions in the development of socio-economic relations.

Secondly, the most important factor in the development of smart cities is the generation of new knowledge.

Thirdly, there are currently no quantitative estimates of the effectiveness of the development processes of smart cities under the conditions of the digital economy in the world's economic literature.

Thus, in order to develop the urgent scientific problem of quantitatively evaluating the development of smart cities in a digital economy, the authors propose a solution based on the tools of institutional economic theory.

II. Theoretical Basis

The methodological basis for the study conducted by the authors was provided in the form of data of an empirical economic study carried out at large and medium-sized processing enterprises in Ekaterinburg. In the course of this empirical research, information was collected on the dynamics of digital resource use and those involved in obtaining new results of intellectual activity over the past five years. A sample of enterprises was formed on the basis of industrial production and the presence of generation processes in enterprises based in the city of Ekaterinburg employing more than 100 people. The sectoral profile of the total of 110 enterprises participating in the study was representative of the aggregate of enterprises in the city of Ekaterinburg. In order to assess the impact of the digital economy on knowledge generation processes, interviews were carried out with top managers of selected manufacturing enterprises based in the city of Ekaterinburg.

During the interview, the following dependencies were verified:

- there is a relationship between the dynamics of digital resource use and the dynamics of the effectiveness of processes of new knowledge generation;
- an increase in the use of digital resources leads to an improvement in the results of knowledge generation processes;
- different types of digital resources affect the impact of different types of new knowledge in different ways.

In order to verify the hypotheses, the authors used a correlation analysis approach showing the relationship between two or more values.

Interpretation of correlation coefficient:

1) more than 0.75 – developed, stable correlation, i.e. a sustainable institution was developed

2) from 0.5 to 0.74 – a changing, unstable correlation, i.e. a developing institution

3) from 0.25 to 0.49 – a partial, unstable correlation, i.e. an emerging institution

4) less than 0.24 – lack of correlation, i.e. an institutional trap

In order to analyse the impact of digital resources on knowledge generation processes, the authors propose a digital knowledge generation rate indicator, calculated using the following formula:

$$Vdij = dKi/dRdj, \quad (1)$$

where:

Vdij – digital generation rate of the i-th type of knowledge when using the j-th type of digital resource.

dKi – increment of the i-th type of knowledge;

dRdj – increment of the j-th digital resource.

As follows from the formula, if Vdij> 1, an increase in the digital resource by 1% leads to an improvement in the effectiveness of knowledge generation by more than 1%, i.e. the growth of new knowledge is greater than the increase in the digital resources used. Knowledge generation activities constructed in this way are considered to be effective.

If 0<Vdij<1, i.e. a 1% increase in the use of a digital resource results in a less than 1% increase in the new knowledge, the institution is deemed to be ineffective,

If Vdij <0, then increasing the digital resource does not lead to a decrease in the effectiveness of knowledge generation. Knowledge generation activities formulated in this way can be described in terms of an institutional trap.

Thus, the digital speed of knowledge generation comprises a quantitative characterisation of the increase in knowledge generation effectiveness in terms of a 1% increase in the use of a digital resource.

III. Results

The pair-correlated dependencies between the types of new knowledge and the use of digital technologies obtained as a result of the study are presented in Table 1.

All three working hypotheses were confirmed from the data analysis of Table 1:

- there is a relationship between the dynamics of digital resource use and the dynamics of the effectiveness of processes of new knowledge generation;
- an increase in the use of digital resources leads to an improvement in the results of knowledge generation processes;

- different types of digital resources affect the impact of different types of new knowledge in different ways.

TABLE 1. CORRELATION DEPENDENCIES AND DIGITAL SPEED OF KNOWLEDGE GENERATION FROM APPLIED DIGITAL TECHNOLOGIES

Norm, actuating factor (x)	**Result, type of new knowledge (y)**			
	New products		***New technologies***	
	Correlation	***Digital speed***	***Correlation***	***Digital speed***
Personal computers	0.91	5.31	0.95	4.79
Servers	0.84	3.29	0.82	3.17
Local Area Networks	0.78	0.95	0.79	1.75
Global networks	0.31	0.73	0.57	1.00
Use of the Internet in organisations	0.31	0.31	0.44	0.34
Broadband Internet access in organisations	0.09	-0,12	0.12	-0,19

On the basis of the obtained empirical data, a typology of knowledge generation institutions of a smart city was formulated.

First of all, institutions were divided into 3 groups: firstly, developed institutions are those institutions for which there is a stable and permanent relationship between a change in the resources used and the result; i.e., the correlation coefficient is greater than 0.75. Developing institutions are those institutions for which the relationship between the change in resources used and the result obtained is observed in most cases, but for which it cannot be said that this is manifested in 100% of cases, i.e., the correlation coefficient is between 0.5 and 0.75. An emerging institution is an institution for which the relationship between a change in resources used and the result obtained is only beginning to be observed and is observed in less than half of cases, i.e., the correlation coefficient is between 0 and 0.5. Subsequently, effective and ineffective institutions were identified in each group of institutions on the basis of digital speed. Separately, the case of an institutional trap was identified; this situation occurs when digital speed has a negative effect on knowledge production. The results are presented in Table 2.

The generated typology of the institutions of knowledge generation of a smart city in the digital economy is graphically presented in Fig.1.

From the analysis of the constructed typology presented in Fig. 1, it can be concluded that the institutional structure of knowledge generation of a smart city under the conditions of the digital economy is currently in a state of formation. It should be noted that, while only 50% of institutions are effective, institutional traps have also arisen even at the stage of forming the institutional structure of generating knowledge in a smart city under the conditions of the digital economy. In the first place, this indicates the need to audit the resources used, along with relevant plans and strategies.

TABLE II. TYPOLOGY OF INSTITUTIONAL KNOWLEDGE GENERATION USING DIGITAL TECHNOLOGIES

Institution type	**Institution name**
Developed effective institution	1) Creation of new products using personal computers 2) Creation of new technologies using personal computers 3) Creation of new products with the participation of ICT servers 4) Creation of new technologies with the participation of ICT servers 5) Creation of new technologies through the use of local networks
Developed ineffective institution	6) Creation of new products through the use of local networks
Developing effective institution	7) Creation of new technologies through the use of global networks
Developing ineffective institution	8) Creation of new products through the use of global networks
Emerging ineffective institution	9) Creation of new products using the Internet in organisations 10) Creation of new technologies using the Internet in organisations
Institutional trap	11) Creation of new products using broadband Internet in organisations 12) Creation of new technologies using broadband Internet in organisations

IV. DISCUSSION

The most effective way to increase the effectiveness of knowledge generation in a smart city under the conditions of the digital society is to increase the use of personal computers. According to the results of the study, a growth in the use of personal computers leads to an increase in the effectiveness of creating new products by 5.31% and new technologies by 4.79%. First of all, in our opinion, this is due to the fact that personal computers, especially the latest models, can significantly increase the number of calculations, modelling processes, development and creation of new products and technologies, while at the same time considerably reducing the use of other resources, such as labour, in the process of generating new knowledge.

The second most important factor in increasing the efficiency of generating new products and technologies in the context of a smart city is the introduction of servers in high-tech enterprises. At the same time, the influence of digital server speed on the efficiency of new knowledge generation is one and a half times lower than when using personal computers. This is explained by the fact that servers, like personal computers, participate in the processes of knowledge generation and act as repositories and arrays for processing big data, which speeds up and cheapens the processes of generating new knowledge in industrial enterprises in a smart city under the conditions of the digital economy

Institutions for creating “New Products” and “New Technologies” using the factors “Personal Computers” and “Servers” are highly efficient and sustainable.

The use of the factors “Personal Computers” and “Servers” is the driver of the development of generation processes by industrial enterprises in a smart city, being equally important for all types of knowledge.

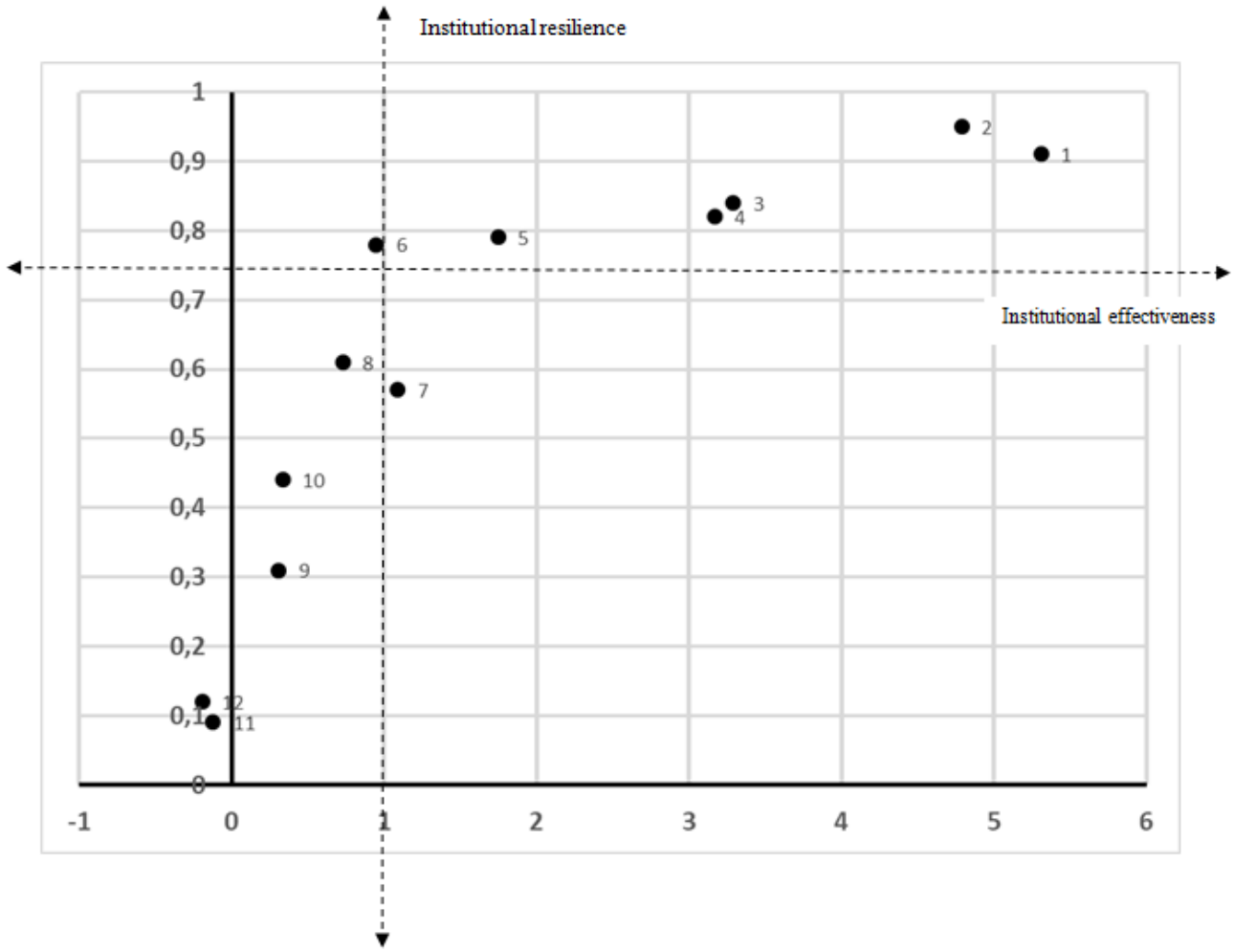

Fig. 1 Distribution of knowledge generation institutions using digital technologies in the coordinates of efficiency / sustainability Here, the stability of institutions is measured in terms of the pair correlation coefficients between knowledge generation products and applied technologies (from 0 to 1), while the effectiveness of the use of institutions is measured in units of knowledge generation speed (from -1 to 6). The dotted lines mark the boundaries of efficiency / inefficiency; institutional sustainability / unsustainability.

The "Local Networks" and "Global Networks" factors have a significantly lower correlation coefficient with the processes of knowledge generation than the two previous factors. The authors conclude that under the influence of the "Local Networks" and "Global Networks" factors, the "New Technologies" and "New Products" institutions are less stable and either comprise developing or borderline developed / developing institutions. Meanwhile, only the institutions for creating "New Technologies" are considered to be effective. This can be explained by the fact that, while local and global networks serve as a tool for transmitting data and communication between employees, they do not have any accelerating effect on the generation processes themselves.

Since, under the influence of using the Internet in organisations, the institutions of "New Products" and "New Technologies" have an even lower correlative relationship, it can be stated that these institutions are only in the process of being formed and are currently ineffective.

On the other hand, an increase in the use of broadband access to the Internet in organisations leads to a decrease in the effectiveness of knowledge generation processes. While the use of this digital resource allows the speed of data transmission to / from the organisation, to be increased it does not affect the processes of knowledge generation in any way. Moreover, in many cases, the availability of broadband Internet leads to its personal use by employees, which can reduce the effectiveness of knowledge generation processes.

From the analysis of the above research results, we can conclude that organisations prefer to use digital resources only to speed up calculations or data storage; therefore, such generation institutions are sustainable and efficient. However, since they do not consider it important to share or receive information from outside the organisation, data transfer is unsustainable and ineffective. In other words, only that which is inside the enterprise is sustainable and effective, while everything connected with the outside world is ineffective and unsustainable.

V. Conclusions

The study carried out by the authors in order to develop a set of tools for quantifying the effectiveness of knowledge generation in the digital economy based on an identification of

the relationship between knowledge generation effectiveness and available digital resources, allowed the following theoretical and practical results were obtained.

Firstly, the indicator of "digital speed" is proposed as a metric for quantitative assessment of the effectiveness of new knowledge generation in the digital economy. The proposed indicator comprises a quantitative characterisation of an increase in the effectiveness of knowledge generation in terms of a 1% increase in the use of a digital resource.

Secondly, the correlation analysis allowed factors associated with the digital economy influencing the processes of knowledge generation in a smart city to be identified. It was shown that such types of digital resources as "Personal Computers" and "Servers" have a stable relationship with such types of new knowledge generation as "New Technologies" and "New Products". Such types of digital resources as "Use of the Internet in Organisations" and "Broadband Internet Access in Organisations" are not interrelated and do not affect the processes of knowledge generation of industrial enterprises in smart cities. It was determined that the use of personal computers and servers increases the efficiency of knowledge generation processes. The use of the Internet by industrial enterprises does not affect knowledge generation processes in a smart city.

Thirdly, digital speeds of increase in the efficiency of generating various types of new knowledge are calculated depending on the various uses of digital resources. It was determined that the highest values of the digital speed of generating new knowledge are achieved using such types of digital resources as "Personal Computers" and "Servers". The use of such types of digital resources as "Broadband Internet Access in Organisations" leads to a negative value of digital speed; that is, a decrease in the efficiency and effectiveness of knowledge generation by industrial enterprises in a smart city.

Fourthly, on the basis of the calculated correlation dependencies and digital speeds of generating new knowledge by industrial enterprises in the digital economy, a typology of the institutions of knowledge generation of smart cities in the digital economy is constructed. When constructing the typology, the stability of institutions was evaluated in terms of the pair correlation coefficients between digital technologies and products of knowledge generation and applied technologies (from 0 to 1), while the effectiveness of the use of institutions is measured in units of knowledge generation speed (from -1 to 6). Sustainable and efficient institutions, whose further development will improve the effectiveness of the processes of generating new knowledge in smart cities under the conditions of the digital economy, are identified. Developed institutions of processes that require special control over their functions to ensure their further evolution into stable effective institutions while avoiding their transition to a state of institutional trap have been defined. An identification of the case of institutional trap, whose elimination is necessary for the release and redistribution of resources in order to increase the effectiveness of the processes of generating knowledge in a smart city, was also carried out.

In this way, the application of principles and ideas of institutional modelling of the processes of generating knowledge in a smart city allow the construction of fully-fledged models for using socio-technological means to drive the growth of smart cities in a digital economy.

The theoretical significance of the study is the development of a set of tools for quantifying the effectiveness of knowledge generation in the digital economy. The practical significance of the study consists in the development of directions for supporting management decisions aimed at increasing the efficiency of knowledge generation in the digital economy.

Acknowledgment

The research is executed with financial support of the Russian Foundation for Basic Research (RFBR) within scientific project No. 18-00-00665.

References

[1] Allam, Z., & Dhunny, Z. A. (2019). On big data, artificial intelligence and smart cities. Cities,89, 80-91. doi:10.1016/j.cities.2019.01.032

[2] Ansong, E., & Boateng, R. (2019). Surviving in the digital era – business models of digital enterprises in a developing economy. Digital Policy, Regulation and Governance,21(2), 164-178. doi:10.1108/dprg-08-2018-0046

[3] Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. Technological Forecasting and Social Change,142, 1-14. doi:10.1016/j.techfore.2018.12.018, Technological Forecasting and Social Change, Vol. 142, 1-14.

[4] Baradaran, V., Farokhi, S., & Ahamdi, Z. (2018). A Model for Evaluation and Development of Citizens Electronic Readiness for Deployment of an E-City Using Structural Equation Modeling. Journal of Global Information Management,26(4), 135-157. doi:10.4018/jgim.2018100108

[5] Camboim, G. F., Zawislak, P. A., & Pufal, N. A. (2019). Driving elements to make cities smarter: Evidences from European projects. Technological Forecasting and Social Change,142, 154-167. doi:10.1016/j.techfore.2018.09.014

[6] Dameri, R. P., Benevolo, C., Veglianti, E., & Li, Y. (2019). Understanding smart cities as a glocal strategy: A comparison between Italy and China. Technological Forecasting and Social Change,142, 26-41. doi:10.1016/j.techfore.2018.07.025

[7] Dudzevičiūtė, G., Šimelytė, A., & Liučvaitienė, A. (2017). The application of smart cities concept for citizens of Lithuania and Sweden: Comperative analysis. Independent Journal of Management & Production,8(4), 1433. doi:10.14807/ijmp.v8i4.659

[8] Geliskhanov I.Z., & Yudina T.N. (2018). Digital platform: A new economic institution. Quality - Access to Success, 19 (S2), 20-26.

[9] Hefnawy, A., Bouras, A., & Cherifi, C. (2018). Relevance of lifecycle management to smart city development. International Journal of Product Development,22(5), 351. doi:10.1504/ijpd.2018.093430

[10] Ismagilova, E., Hughes, L., Dwivedi, Y. K., & Raman, K. R. (2019). Smart cities: Advances in research—An information systems perspective. International Journal of Information Management,47, 88-100. doi:10.1016/j.ijinfomgt.2019.01.004

[11] Kobayashi A.R., Kniess C.T., Serra F.A., Ferraz R.R., & Ruiz M.S. (2017). Smart Sustainable Cities: Bibliometric Study and Patent Information. International Journal of Innovation, 5 (1), 77-96.

[12] Negrea A., Ciobanu G., Dobrea C., & Burcea S. (2019). Priority aspects in the evolution of the digital economy for building new development policies. Quality - Access to Success, 20 (S2), 416-421.

[13] Nepelski, D. (2019). How to Facilitate Digital Innovation in Europe. Intereconomics,54(1), 47-52. doi:10.1007/s10272-019-0791-6

[14] Herscovici, A. (2018). New development: Lean Thinking in smart cities. Public Money & Management,38(4), 320-324. doi:10.1080/09540962.2018.1450924

[15] Nilssen, M. (2019). To the smart city and beyond? Developing a typology of smart urban innovation. Technological Forecasting and Social Change,142, 98-104. doi:10.1016/j.techfore.2018.07.060

[16] Novikov, D., & Belov, M. (2018). Methodological Foundations of the Digital Economy. Big Data-driven World: Legislation Issues and

Control Technologies Studies in Systems, Decision and Control,3-14. doi:10.1007/978-3-030-01358-5_1

[17] Raven R., Sengers F., Spaeth P., Xie L., Cheshmehzangi A., & Jong M. (2019). Urban Experimentation and Institutional Arrangements. European Planning Studies, 27 (2), 258-281.

[18] Sepasgozar, S. M., Hawken, S., Sargolzaei, S., & Foroozanfa, M. (2019). Implementing citizen centric technology in developing smart cities: A model for predicting the acceptance of urban technologies. Technological Forecasting and Social Change,142, 105-116. doi:10.1016/j.techfore.2018.09.012

[19] Todoruț A.V., & Tselentis V. (2018). Digital technologies and the modernization of public administration. Quality - Access to Success, 19 (165), 73-78.

[20] Watanabe, C., Tou, Y., & Neittaanmäki, P. (2018). A new paradox of the digital economy - Structural sources of the limitation of GDP statistics. Technology in Society,55, 9-23. doi:10.1016/j.techsoc.2018.05.004