SMART CITY ECOSYSTEM: ELEMENTS OF CONCEPT, COORDINATION CHALLENGES AND FUNDING MECHANISMS IN RUSSIA

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Abstract: *The article deals with the content and evolution of the concept of a smart city. The author identifies the role of the smart city concept as the theoretical foundation for the research into the ecosystem. The significance of standardization is shown as it is a condition for coordinating the interaction of numerous ecosystem members. The author puts forward and confirms the hypothesis on the need to build a standardized ecosystem of the smart city centered around information technologies that determine the economic value of digital infrastructure for city residents which leads to understanding the pattern of expecting returns from investments into digital infrastructure facilities. The characteristics of the smart city funding model are revealed: the state's use, along with budgetary allocations, of indirect support measures through tax preferences and social technologies, direct measures through grants and subsidies, as well as the attraction of private investment through public-private partnerships. The models of return on investment are systematized within various forms of interaction between business and the state. The results of the study can be applied to bolster business activity in terms of including the smart city program based on the principles of public-private partnership.*

Keywords*: smart city, urbanization, human capital, digital transformation, standardization, value, ecosystem, public-private partnership, concession, return-on-investment models, tax preferences, subsidies, grants, crowdfunding.*

INTRODUCTION

Already back in the 1960s, the English scientist Derek Price proved the law of exponential growth of the volume of accumulated information (Price, 1963) caused by an increase in the number of staff members who process the information. In the modern world, an increase in the number and variety of relationships occurs between all actors of socio-economic relations: organizations and citizens, citizens and the state, the state and business which is accompanied by an increase in transactions and volumes of information called "digital data" created and accumulated due to the information technology (IT) infrastructure. The rapid pace of IT penetration into all areas of society's life has led to changes in the familiar models of the structure of the state's economic and social life, influencing people in two directions: on the one hand, presenting a demand for highly qualified human capital and, on the other hand, fostering the growth of human capital, including through the organization of a person's living space and reducing the time spent on obtaining government and financial services, as well as services in the field of education and health, due to the use of digital technologies. The latter gave rise to the formation of the smart city concept.

We put forward a hypothesis: further progress towards human capital growth in the context of urbanization and digital transformation builds a standardized ecosystem of

a smart city centered around IT that determine the economic value of digital infrastructure for city residents. This ensures the transformation of this value into an advantage for business representatives and in the future – in the cost for which the state, participating in the regulation of development and the funding of facilities on the principles of public-private partnership, will compensate private investors. To confirm the hypothesis, one must study: the development stages and elements of the smart city concept; the structural components of the smart city project and the factors of their appeal for the population that form the value; the growth of the economic value of smart city elements during the coronavirus pandemic; the significance of standardization for coordinating member interactions and building the smart city ecosystem; the justification of the smart city funding model and return-on-investment mechanisms in the context of state and business partnership that act as manifestations of transforming the value of smart city elements into the cost.

METHODS

The materials of the study include Russian and foreign research publications on the theories of human capital, spatial economics, digital economy, standardization and investment. The factual framework of the study consists of analytical reports by the global consulting firm McKinsey and the first infrastructure company InfraOne and the results of studying the experience of implementing IT-infrastructure into the local activities aimed at forming smart city solutions. The methodological basis of the research is comprised of the approaches to evaluating the factors and efficiency of citizens' digital technology use and their utilization for solving the tasks of the economy of the smart city, as well as the mechanisms of standardization and funding. The information basis of the study consists of legislative documents of the Russian Federation (the RF) that regulate the housing and utilities sector, digital economy and public-private partnership, materials of the Ministry of Digital Development, Communications and Mass Media of the RF, the Ministry of Construction Industry, Housing and Utilities Sector of the RF, the Ministry of Finance of the RF and the National Center for Public-Private Partnership.

RESULTS

Urbanization and digital economy: mutual influence and its consequences

The conceptual foundations of the digital economy were laid down in the late 20th century. The term "digital economy" was introduced into the scientific discourse in 1995 by a professor at the Massachusetts Institute of Technology Nicholas Negroponte. In general, the digital economy is interpreted as a set of economic relations based on digital technologies connected to electronic business and e-commerce, production and sale of electronic goods and services. Payments for services and goods in the digital economy are often made with electronic money (Maksimova, 2020). In Russia, the implementation of digital technologies into the economy and social processes is becoming a national goal. To achieve such an ambitious goal, the following must develop and grow within the economy and society: the demand from the population and business for IT services and the supply of these services from firms directly focused on citizens, that is, there must be relations described as B2C and G2C (Ustyuzhanina, Dubovik, 2020). The growing role, importance and quality of human capital have an impact on the modern economy in the following

areas. First, in the global information economy, human capital is transformed into network human capital which is the competences of highly qualified actors who interact via the Internet with government organizations, firms and other citizens to obtain public goods and network effects (Dyatlov, 2019). Second, it is human capital with the use of new competences and digital technologies that act as a resource, that creates product and technological innovations. The most important property of human capital is the constant production and consumption of new knowledge. The American sociologist Richard Florida calls workers who consume and produce new knowledge "the creative class" (Florida, 2007). Third, the continuous process of production and use of knowledge contributes to increased convenience and safety of urban life by optimizing energy consumption, eliminating traffic jams and accidents; reliability of city transport; the use of navigation when plotting routes for personal vehicles; increased availability and quality of services in such important areas of life as medicine, education, municipal and state services, culture, housing and utilities, finance. Fourth, the desire to have a job and high-quality living conditions, as well as the wish to provide meaningful work and comfortable living for the children in the future, have led to urbanization: an increase in the urban population.

According to UN estimates, the world's urban population reached 4.2 billion in 2018, or 55% of the world's total population (Shcherbakova, 2018). The populations of Hong Kong, Singapore, Kuwait and Monaco are entirely urban. A characteristic of Russian urbanization is that the population does not migrate from rural areas to cities but from small towns to large ones. Russia ranks 60th in the ranking with a share of the urban population – 74.4% (Reiting urbanizatsii stran mira, 2020). The UN Department of Economic and Social Affairs published a prospect that predicts that by 2050 two thirds of the global population will be urban (World Urbanization Prospects, 2018). The burden on the urban transport system will continue to increase, the need for social services will grow, the environmental condition will decline. As a result, the demand for smart projects in all areas of the economy will increase and so will the need for their funding (Figure 1).

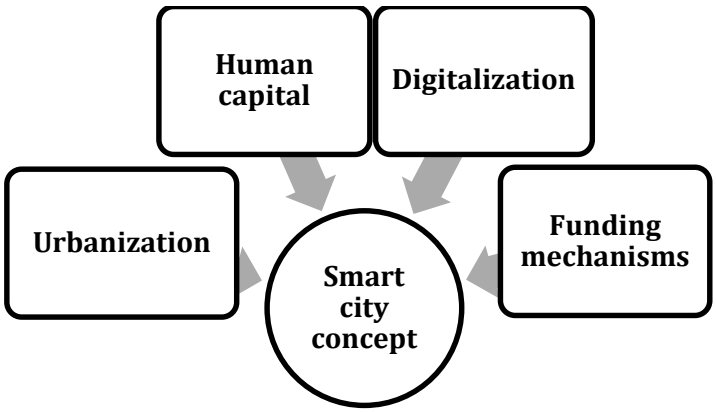

Figure 1. Elements constituting the smart city concept

Currently, most countries have adopted or are in the process of adopting programs for the development of smart cities, and one can expect that with an increase in the world's urban population, the need for digitalization of cities will increase. The growing urban population creates the basis for digital solutions, and, at the same time, makes them necessary. Thus, the elements constituting the smart city concept are urbanization, growth of human capital, digitalization and funding mechanisms.

The essence, evolution and development stages of the smart city concept

Some provisions of the concept of smart cities began to form in the early 2000s. Initially, the authors described the territories, the characteristics of which were primarily associated with the city of wealthy people doing business and did not imply meeting the needs of the wider population. In 2008, the British sociologist Robert Hollands (2008), having concluded that the concept featured few smart solutions for ordinary people, attempted to revise the concept of a smart city. According to Hollands, smart cities should help improve the lives of all segments of the urban population, reduce the level of inequality in the income distribution of the population thanks to access to IT and also ensure control over municipal authorities (Figure 2).

Economy	Environment	Society and culture
• IT • Innovation • Employment • Trade • Performance • Physical infrastructure	• Air quality • Water supply • Noise • Quality of environment • Biodiversity • Energy	• Education • Health care • Safety • Housing • Culture • Social inclusion

Figure 2. The indicators of smart cities developed by the UNECE (The UNECE–ITU Smart Sustainable Cities Indicators, 2016).

Research by the McKinsey Global Institute (MGI) reveals the stages in the development of the smart city concept. The concept was formed in the early 2000s, became a manifestation of digitalization and informatization of the economy and was aimed at developing IT. Among other things, the study revealed that not all innovations were in demand by the population: sometimes the most innovative sensors did not find support among the city population. For example, an intelligent gas meter system proposed in Russia would presumably cost 385 billion rubles, if implemented, which would cause an increase in tariffs and become significant for the Russians' budgets (Volokhina, 2019). Moreover, during the initial period in the development of the concept, isolated episodes of the application of new technologies were mainly considered, with an emphasis on B2G relations. The third disadvantage of the concepts during the initial period was the technological understanding of the subject: the publications lacked social, cultural and environmental aspects. The justification of these factors led to the fact that in 2013, critical reviews of the smart city concept began to be expressed that were substantiated by experts in the field of urban planning and IT, authors of well-known books: A. Townsend (2013) and A. Greenfield (2013). The result of their research was the conclusion about the need to involve the population in the development and improvement of the technological efficiency of innovations. Researchers from the MGI identified the period of 2013-2015 as the time when the first stage of the "Smart Cities 1.0" concept was completed and the countries of the world transitioned to the second stage of the "Smart Cities 2.0" concept. This concept included the transition from technologies to the goals of

urban development and the efficiency of their achievement, the attraction of project participants from different sectors of the economy and focus on the population's interests. The proof that technologies are secondary to the significance of the urban population's comfort and safety is the fact that cities, rather than technology providers, led the "Smart Cities 2.0" city rankings. The concept of "Smart Cities 3.0" is currently being formed in developed countries; it includes a highly intelligent integrated city that stimulates the formation of social capital and entrepreneurship. The system promotes the involvement of citizens, their transition to being active participants in the transformation of urban life, the manifestation of democracy and the rule of the people.

Components of the smart city project and the factors of their appeal for the population

What is the difference between a smart city and a regular city? In literature, there are two main approaches to finding an answer to this question: technological, based on the analysis of applied IT and complex, taking into account, in addition to IT, the urban population involvement in the decision-making process, the presence of feedback, participation in the formation of local budgets and interaction with the administration. It was the second approach that expressed the essence of the "Smart Cities 2.0" concept. Understanding the meaningfulness and potential of the second approach application, one cannot ignore the technological approach which serves as the basis for the extended paradigm. The success of the smart city project depends to a large extent on the availability of the Internet throughout the country. Broadband Internet access in Russia is extremely uneven (Table 1).

Table 1. The number of fixed broadband Internet subscribers per 100 people

Region	The RF	Moscow	Novosibirsk Region	Tyumen Region	The Republic of Tatarstan	The Republic of Dagestan	The Republic of Ingushetia
Number of subscribers	21.66	35.96	36.37	25.36	25.68	2.55	1.18

Compiled by the author based on the data (Website of the Ministry of Digital Development, Communications and Mass Media of the RF, n.d.)

If Moscow and Novosibirsk are cities with developed broadband Internet access and a large number of subscribers, then the Republics of Ingushetia and Dagestan show a significant limitation in this indicator of the digital economy development which is crucial for ensuring the proliferation of smart city technologies and the growth of the number of users. The components of a smart city in the second concept can be divided into two groups: solutions for a smart city and solutions for a smart city for the population. The first group encompasses urban infrastructure: smart street lighting, video surveillance, handling of solid residential waste (SRW), environmental monitoring, intelligent transport system, building automation system, public Wi-Fi access spots that are invisible to citizens but make their life in cities safe and healthy. However, such an idea of the smart city components seems somewhat simplified since in the cities that are leaders in the implementation of the smart city concept, a digital model of each building is formed which makes it possible to assess its spatial model, the chance of emergencies, to provide access

to the building to minimize service staff, which is then able to turn into a digital model of the city. The emergence of the "digital twin of the city" will facilitate urban planning, improve the investment climate and be used for political decision-making.

The second group includes objects created to make people's lives easier but implemented with their participation: electronic government services, car-sharing, parking payment applications, bicycle rental systems, online taxi, online education, digital appointments and medical records in clinics, home deliveries of food and groceries. Most smart solutions involving citizens do not require government supervision or control. The accumulation of databases and significant investments in the IT industry have led to the emergence of smart sensors and electronic networks and the formation of four technology layers. The ecosystem of "Smart City technologies" has been formed (Figure 3).

Level 1.	• Consumers and interfaces.
Level 2.	• Public and commercial services, including information systems and applications, providing digital services in various areas of the city's life.
Level 3.	• Data generated by infrastructure, information systems and users, including data from city platforms and other urban information resources.
Level 4.	• Digital infrastructure: telecommunication networks, data storage and processing centers, devices for receiving data from the environment (video surveillance system, navigation systems and other sensors)

Compiled by the author based on (Kamanin, 2019)

Figure 3. The Ecosystem of smart city technologies.

What are the influencing factors that explain the development of smart cities and the choice of people who want to live in such cities and use smart city solutions? An attempt to find an answer to this question was made by researchers from the MGI (Woetzel, et al., 2018). Investigating solutions for smart cities that make life easier for their population, the MGI surveyed residents of 15 different cities around the world, including Moscow, and analyzed their assessments of these services. Most of the population uses public transport, taxis, government services, clinics, so smart technologies in these areas are the most popular and improve the accumulated user experience. The preservation of behavioral stereotypes in the use of smart solutions is a factor that explains their popularity among city residents and forms their value for future investors. Other smart technologies are not as popular in all cities. For example, this refers to bicycle rental which has not been properly developed in Russia due to the unsuitable climate but is widespread in China where the population traditionally uses bicycle

transport. In this case, climatic conditions are a limiting factor in the demand for smart technologies. Most smart technologies do not require people to change their model of behavior: a person has been driving and continues to drive, only now with an application for real-time car navigation. However, the use of car-sharing forces a person to change the model of behavior: one must get used to the fact that other people also drive this car and the car can be difficult to find. The need to change the model for consumers is a limiting factor in the demand for some smart solutions.

Standards and ratings of the smart city ecosystem

The smart city concept does not exist separately from the concept of the digital economy but is its main part and acts, like the digital economy, as a global trend in human development. The World Economic Forum in Davos in 2016 recorded the transition of the global economy to the fourth technological paradigm which radically changes the paradigm of organizing urban life. The 2015 Paris agreement to combat climate change also influences the way cities function. This allows one to conclude that the global nature of the smart city concept confirms the impossibility of its local implementation within the framework of one city or state and requires the collective effort of all mankind. At present, smart city projects are isolated solutions. Large state corporations and state-owned companies have tried working in this area: Rostelecom, Rostec (electronic cluster), Sberbank, Rosatom, large private companies: Lanit, Kaspersky, I-Teco and a lot of medium and small enterprises. Many participants in the smart city project exposes the problem of their lack of integration, justifying the need for coordination of interaction between system elements and between the systems themselves, aimed at compatibility and integration of solutions. Such horizontal coordination and cooperation will foster the transition from pilot projects to commercial operation of the project systems. The interrelation and coordination of the participants' activities will contribute to reducing the costs of purchasing technologies and equipment due to eliminating duplicated solutions, ordering identical or similar works; reducing the risk that an important part of the overall set of works will not be performed due to the lack of coordination of actions for its implementation; creation of common standards.

Standards are the norms and values of indicators that are applied on a large scale and collectively so that all participants have the same concepts and values of characteristics for an object or activity (Kupriyanovskii, Namiot, 2016). All the positive experience accumulated in the world should be reflected in the standards and the indicators of smart city standards should contain data evaluating the city from the perspective of the population, tourists, investors and government officials. The process of international standardization of smart cities at the level of the head organization – the International Organization for Standardization (ISO) – began in 2014. Although the ISO was created recently – in 1946, it has contributed substantially to the globalization of world markets. At the end of December 2019, the final edition of the international standard "Information Technology. Smart Cities. Smart City ICT Indicators" was presented. The development of this standard has been the result of the cooperation of experts from several countries, including Russia, which will ensure the rapid adaptation of the standard's indicators to Russian conditions and the unity of basic approaches. For solutions and products of Russian companies to have export potential, the solutions and products must enter the international engineering and technological ecosystem. Based on this standard, the technical committee "Cyberphysical systems" at the Russian Venture

Company in cooperation with the All-Russian Institute for Certification, presented for public discussion eight preliminary national standards in the field of smart cities in March 2020.

The norms and indicators of international and national standards have become the basis for compiling the smart city ratings. The Competitiveness Department of the International Institute for Management Development in partnership with the Singapore University of Technology and Design has compiled the "Smart Cities 2019" rating where the top three are Singapore, Zurich and Oslo. Moscow has been a full-fledged subject of these studies since 2017 and is in 72nd place (IMD Smart City Index 2019, 2020). To study the implementation of the smart city project in Russia, the Ministry of Construction Industry, Housing and Utilities Sector of the RF together with scientists from the Lomonosov Moscow State University, in 2020 worked on designing the digitalization index (IQ) of the Russian urban economy as of 2018. IQ of cities was calculated in ten aspects and included 47 indicators. The methodology for calculating the city IQ index requires the division of cities into four groups by population size. Apart from Moscow which ranks first among cities with a population of over 1 million, this group includes Kazan and St. Petersburg. The group with the population from 250 thousand people up to 1 million people, in addition to the cities of the Moscow region, only Tyumen is in the top three. In the other groups, the top three are the cities of the Moscow region. The city digitalization index shows the extreme unevenness in the development of this process in Russian cities. This is mainly due to limited regional budgets and the uneven spread of broadband Internet (The Index of Digitalization of Municipal Services "City IQ", 2020). Only the allocation of funds from the federal budget for the implementation of regional "Digital economy" programs and the attraction of private investment can bolster the Russian market.

The effect of the external shock of the COVID-19 pandemic on the sectors of the smart city project

The coronavirus pandemic announced by the World Health Organization (WHO) has affected 188 countries and the number of those infected exceeded 9.3 million people as of 24 Jun. 2020. The Russian authorities have been trying to limit the spread of the disease since the end of January (closing connections with China), but the strictest and the most large scale measures were taken in the second half of March and lasted until 16 Jun. 2020. At present, soft restrictions remain. If aviation, rail and road transport incur huge losses, then the restriction of population mobility has caused an increase in remote communication between citizens and the transition of many companies' operations to a remote mode. The time has come for the increased demand for the services of the smart city project sectors. This has become a significant factor in the increase in the value of the smart city IT infrastructure facilities (Goryainova, 2020). Russian regions with access to broadband Internet were able to organize within a short period: online delivery of food and transportation of necessary goods; education in schools and universities; monitoring the observance of self-isolation of persons infected or recovered from coronavirus; medical consultations; video services that offered to view concerts, plays and films, dance, yoga and fitness classes. All this radically transformed the life of the urban population, allowing them to preserve their health during self-isolation. In this situation, working remotely for many companies has become the only way to continue existing. Employees went online and a client base was formed. However, the population's demand for the

traffic of the online services of the smart city varies. There are no exact statistics on this but some studies of changes in the traffic of online resources have already been carried out (Table 2).

Table 2. Service-producing industries with an upward revenue trend during the pandemic in Russia

Service-providing industry	Surplus revenue volume from the imposition of restrictions to 20 Apr., billions of roubles	Share of surplus revenue in the total annual revenue of the industry*, %	Reasons for the upward trend
Mobile connection	27.2	2.7%	An increase in the number of people working remotely and the implementation of self-isolation.
Broadband internet access	6.5	3.3%	
Online services (food delivery, film streaming)	3	5.4%	
Data processing centers	0.7	2.1%	An increased load due to increased internet traffic and more active use of IT in general (including for video surveillance and online conferences).

*Total revenue of the industry was considered as its forecast value for 2020 without the impact of coronavirus (Infrastrukturnye otrasli s polozhitelnoi dinamikoi vyruchki vo vremya pandemii v Rossii, 2020).

Funding instruments to stimulate the development of smart city technologies

The state should support the implementation of smart city projects in every possible way through the instruments of indirect (tax preferences) and direct regulation (grants and subsidies), as well as public-private partnerships. Currently, there are no concepts of "innovation" or smart city the Russian tax legislation, and *tax relief schemes and preferences* related to innovative and technologically intensive enterprises apply only to research and development. These preferences include exemption from VAT when implementing the results of research and development; accelerated procedure for awarding depreciation of fixed assets acquired for research and development; a zero income tax rate for educational and medical institutions carrying out research and some other preferences. Moreover, Russian legislation provides for an investment tax credit for organizations engaged in research and development or technical modification of their own production. There are also stimulus measures for innovative companies located territories. This applies to enterprises located in special economic zones, territories of advanced development, technology parks as well as participants in the projects of the Skolkovo Foundation. It should be noted that these indirect support measures hardly ever apply to smart city projects since to receive them, one must collect a lot of documents which makes them extremely unpopular among entrepreneurs. In July 2020, a decision was made by the Russian Ministry of Finance on amendments to tax legislation related to IT companies. Russian IT companies will receive tax preferences: it is planned to reduce

their insurance contributions from 14 to 6%, and income tax from 20 to 3%. These preferences will be valid indefinitely. The bill was submitted to the Government of the RF (On the tax maneuver in the IT industry, 2020).

In May 2019, a decree of the Government of the RF was adopted that provided for the allocation of *subsidies* from the federal budget for the implementation of digital projects in cities. A prerequisite is the availability of private funding sources (The Decree of the Government of the RF №550, 2019). Moreover, the Ministry of Finance plans to allocate *grants* for new developments up to 250 million rubles per year but not more than 50% of the expenses of IT companies. As the local budgets are limited, there is an urgent need to attract private capital through *public-private partnerships (PPP)*. While the authorities spend funds on socially significant initiatives that reduce queues in government institutions, combat crime, optimize the transport network, increase the efficiency of patient treatment, etc., private companies are interested in implementing the most profitable projects. When these value factors converge in one project, we can talk about the possibility of implementing joint initiatives by the state and business in various formats of PPP. The implementation of IT infrastructure projects on the PPP basis is carried out according to Russian legislation in the form of concession agreements (CA) (Federal Law dated №115-FZ, 2005) and PPP agreements (PPPA) (Federal Law №224-FZ, 2015). However, until recently, neither law contained an indication of the possibility of using these legal documents concerning IT objects without associating them with the immovable or movable property which negatively affected the investors' activity. These problems were solved due to the adoption of the Federal Law dated 29 Jun. 2018 №173 "On the Amendment of Certain Legislative Acts of the RF" that provided for the inclusion of IT infrastructure facilities in the list of CA and PPPA objects (Federal Law №173-FZ, 2018). With the adoption of this legal document, IT become independent objects of CA and PPPA which creates conditions for the formation of a PPP market in the field of IT infrastructure. The lack of the need to include real estate objects in the transaction makes the transaction more flexible, ensuring the attraction of not only large but also small firms (Figure 4).

IT objects	Technical means that ensure the operation of IT infrastructure	Data processing centers
• computer software • databases • information systems • Internet websites	• IT objects • property technologically connected to IT objects and designed for their operation	• buildings and rooms • providing access to information • information provision

Figure 4. Objects of IT infrastructure (Federal Law №173-FZ, 2018)

In this case, one is supposed to use a life cycle contract stipulating the conditions for the provision of goods or performance of work, operation and disposal of goods supplied or created during the performance of work (Federal Law №44-FZ, 2013). A special form of the contract is an energy service contract that describes the actions aimed at increasing the efficiency of the customer's use of energy resources. Programs that have

a business result are being implemented with the participation of PPP but so far there are few such projects, most of the projects are socially oriented. A common return-on-investment model is availability payments where the public side pays the private side for the facility's operations. The revenue received from consumers goes to the concession provider (the state) which, taking into account the quality and condition of the object, directs funds to the concessionaire without taking into account consumer demand and, as a result, the risks fall on the state (Goryainova, 2020). Depending on the form of business entity of the structure and funding of PPP, various models of return on investments in smart city projects are available (Figure 5). In the PPP market, there are several problems related to the implementation of IT projects which may be caused by the lack of experience of participants in structuring the latter. First, the problem of implementing digital concessions and PPP is that 115-FZ and 224-FZ restrict the conclusion of agreements with foreign companies (and those under the foreign influence) which significantly narrows the list of possible participants in such projects. Second, it is also unclear whether IT solutions developed by a private partner under a concession or PPP can be replicated and how the rights to intellectual property are supposed to be distributed between the parties. The state may be deterred from participating in the project by its unwillingness to give private investors access to protected data which the state has a monopoly on which is important from the perspective of the commercialization of the project and the investor's interest in participation. Third, for now, the practice of selling digital products (and not property) in concessions and PPP is not common. This leads to uncertainty about how the cost of creating IT objects should be estimated for the public and private parties to be satisfied. Fourth, the implementation of projects in IT in general and in smart cities, in particular, is hindered by the low level of the basic telecommunication infrastructure development in Russian regions. According to experts, so far, Moscow and St. Petersburg can be growth centers in this field as well as – but lagging – 45 other regions where telecommunications are better developed than in Russia on average. These regions have fewer problems with access to broadband Internet, mobile and landline communications are more developed, and local companies are more "technological". However, the gap between the most developed and the least developed federal subjects remains significant: the national average value of the telecommunications index is 6.45 out of 10.

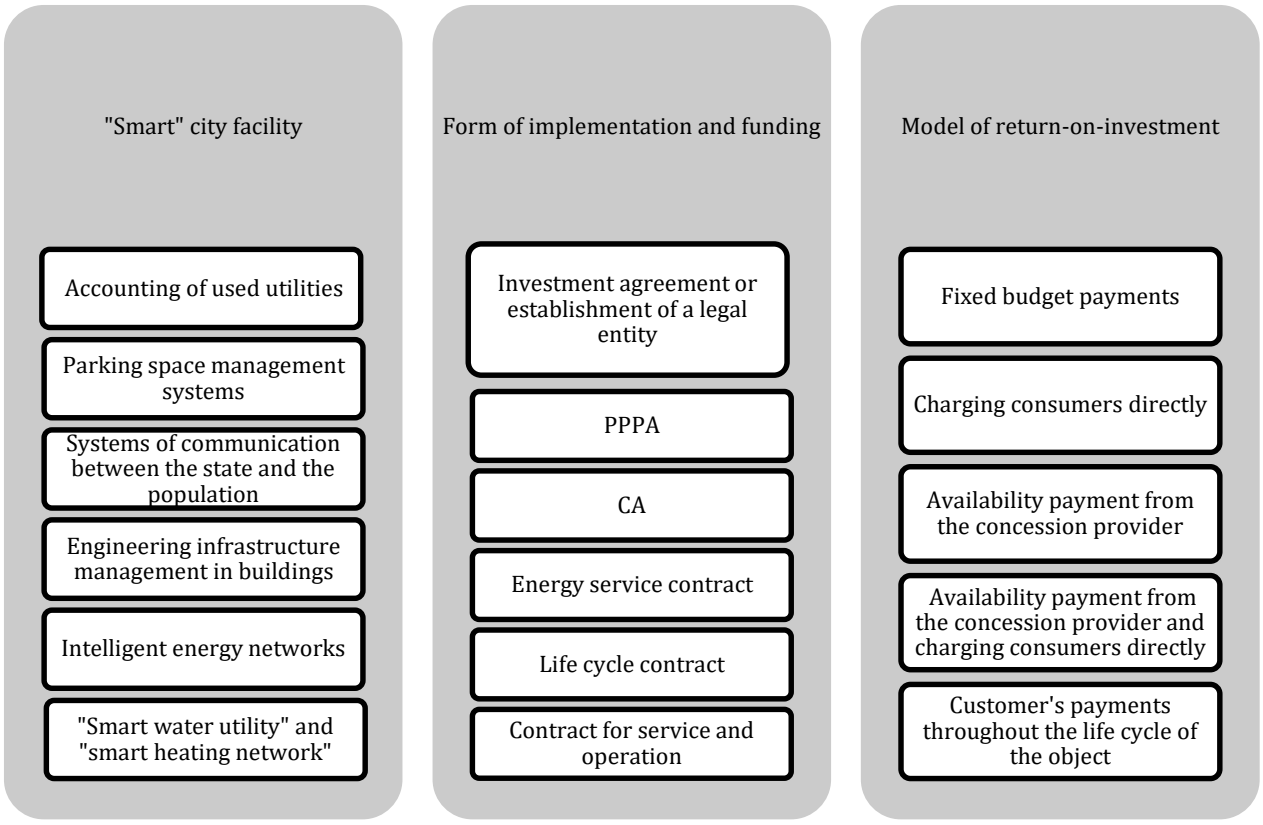

Figure 5. Models of return-on-investment in smart city projects based on PPP in Russia (The Website of the National Center for Public-Private Partnership, n.d.)

Finally, many digital projects are platforms and it is still unclear whether the platforms can become objects of concessions and PPP agreements and how the authorities will interact with each other if such projects turn out to be multifunctional, that is, connected to various industries. An alternative funding instrument is *crowdfunding*, a collective investment mechanism, with the help of which city residents can act as co-investors in the implementation of small projects in the smart city concept. For organizing the collection of money, online platforms are used: Planeta.ru, Boomstarter.ru, etc., the capabilities of which are still rarely used for introducing digital technologies in cities. In Russia, this tool is widely used not to fund smart city projects but to raise funds for publishing books and releasing music albums. The development of tax incentives and financial support for IT for the development of territories could foster the implementation of smart city projects in Russia. At the same time, other mechanisms that have become widespread in the world should also be developed. Examples include the numerous initiatives within the framework of PPP, support for crowdfunding and the launch of investment technology platforms.

DISCUSSION

Theoretical approaches that reveal the essence of the concept and content of the smart city project are currently the subject of debate. The research confirms that the objective reasons caused by socio-economic development have led to the transition to an expanded interpretation of the concept that consists of urbanization, human capital, digitalization and funding mechanisms. Based on this theoretical concept, the smart city

ecosystem is formed. The result of the ecosystem operation is the creation of conditions for the development of a smart city and the observance of the interests of all ecosystem participants. The term "ecosystem" defines the priority of natural factors. Therefore, the inclusion of the state in the ecosystem structure is also arguable. Our inclusion of funding mechanisms in the ecosystem may become debatable but the lack of funding from local budgets is the most important reason for the non-uniform spread of smart city technologies across Russia which increases the importance of these mechanisms, without which technological solutions cannot be implemented.

CONCLUSION

Therefore, modern society, becoming a society of urban residents, as a result of IT development, creates the conditions for human capital growth and the opportunity for transitioning from discussing the issues of the essence and the characteristics of the theoretical concept of smart city to practical aspects. Smart city seems to be a global concept aimed at solving social and economic problems using IT which requires a lot of resources and the participation of city services, organizations, businesses, citizens and the state. The model of the territory developed as a result of actions on smart solutions forms an ecosystem that consists of objects, subjects, technologies and the institutional environment. Ecosystem technologies, in addition to digital ones, include a set of funding forms and tools: from budget allocations to forms of attracting private investment, including payments for consumers' access to smart city services. The state must be included as a subject of this system, on the one hand, to form a regulatory legal environment and, on the other hand, to create an atmosphere of trust in smart solutions for the city, thereby stimulating the demand for their services. These conditions foster the understanding of the fact that an active state policy determines the success of the smart city project and the operation of the digital economy. However, no matter how active the position of the state is, it should be understood that it is impossible to achieve the success of the smart city project through the efforts of one city or country as it requires international cooperation in the development of the regulatory framework, the development of export of IT products and services and holding international events.

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REFERENCES

1. Price, D.J. (1963). Little Science, Big Science. New York: Columbia University Press.
2. Maksimova, V.F. (2020). Ekonomicheskaya teoriya [Economic theory]: textbook. Moscow: Yurait.
3. Ustyuzhanina, E.V., Dubovik, M.V. (2020). Kontseptualnye aspekty razvitiya ekonomiki Rossii: vyzovy i prioritety [Conceptual aspects of development of Russian economics: challenges and priorities]. Moscow: Knorus.

4. Dyatlov, S.A. (2019). Setevoi chelovecheskii kapital millenialov kak draiver razvitiya tsifrovoi ekonomiki [Millennial network human capital as a driver for the development of the digital economy]. Izvestiya Sankt-Peterburgskogo ekonomicheskogo universiteta, 4, 26-31.
5. Florida, R. (2007). Kreativnyy klass: lyudi, kotorye menyayut buduschee [Creative class: people who change the future]. Moscow: Klassika XXI.
6. Shcherbakova, E.M. (2018). Prognoz gorodskogo i selskogo naselenii mira [Prognosis of global urban and rural population]. Demoskop Weekly, 773-774. Retrieved from: http://www.demoscope.ru/weekly/2018/0775/barom02.php.
7. Reiting urbanizatsii stran mira. (2020). Gumanitarnaya entsiklopediya: Issledovaniya [Global urbanization rating by country. Encyclopedia of humanities: research]. Tsentr gumanitarnykh tekhnologii, 2006–2020. Retrieved from: https://gtmarket.ru/ratings/urbanization-index/info.
8. World Urbanization Prospects (2018). The Department of Economic and Social Affairs. Website of the United Nations (UN). Retrieved from: https://population.un.org/wup/.
9. Hollands, R.G. (2008). Will the real smart city please stand up? City, 12(3), 303-320.
10. The UNECE–ITU Smart Sustainable Cities Indicators. (2016). UN Economic Commission for Europe. Retrieved from: https://www.unece.org/fileadmin/DAM/hlm/documents/2015/ECE_HBP_2015_4.ru.pdf.
11. Volokhina, S. (2019). Umnye ochen: na tsifrovye goroda khotyat vydelit do 35 mlrd rublei [Very smart: digital cities to be funded with up to 35 billion roubles]. Izvestiya. Retrieved from: https://iz.ru/862075/svetlana-volokhina/umnye-ochen-na-tcifrovye-goroda-khotiat-vydelit-do-35-mlrd-rublei.
12. Townsend, A.M. (2013). Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia. New York: W.W. Norton & Company.
13. Greenfield, A. (2013). Against the Smart City. London: Do projects.
14. Website of the Ministry of Digital Development, Communications and Mass Media of the RF. (n.d). Retrieved from: https://digital.gov.ru/opendata/7710474375-abonentishpd/table/.
15. Kamanin, I.O. (2019). Novoe ponimanie informatsionnykh resursov umnogo goroda [A new understanding of a smart city's informational resources]. Vestnik Universiteta Pravitelstva Moskvy, 4, 11–14.
16. Woetzel, J., Remes, J., Boland, B., Lv, K., Sinha, S., Strube, G., Means, J., Law, J., Cadena, A., von der Tann, V. (2018). Smart Cities: Digital Solutions for A More Livable Future. Retrieved from: https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future.
17. Kupriyanovskii, V.P., Namiot, D.E., Kupriyanovskii, P.V. (2016). O standartakh umnykh gorodov, interneta veshchei i bolshikh dannykh. Soobrazheniya po prakticheskomu primeneniyu v Rossii. [On the standards of smart cities, the internet of things and big data. Considerations for the practical implementation in Russia]. Mezhdunarodnyi zhurnal otkrytykh informatsionnykh tekhnologii, 4(2), 34-40.
18. IMD Smart City Index 2019 (2020). Retrieved from: https://www.imd.org/smart-city-observatory/smart-city-index/.
19. The Index of Digitalization of Municipal Services "City IQ". (2020). Website of the Ministry of Construction Industry, Housing and Utilities Sector of the RF. Retrieved from: https://www.minstroyrf.ru/press/minstroy-rossii-predstavil-pervyy-indeks-iq-gorodov-/.

20. Goryainova, L.V. (2020). Kontseptsiya "Umnyi gorod": evolyutsiya, perspektivy razvitiya i mekhanizmy finansirovaniya v Rossii [The smart city Concept: Evolution, Prospects and Funding Mechanisms in Russia]. Ekonomika predprinimatelstva, 2, 393-399.
21. Infrastrukturnye otrasli s polozhitelnoi dinamikoi vyruchki vo vremya pandemii v Rossii [Service-producing industries with upward revenue trend during the pandemic in Russia]. (2020). InfraOne Research Weekly, 9(33). Retrieved from: https://infraone.ru/sites/default/files/analitika/2020/infraone_research_weekly_09_33_08052020.pdf.
22. On the tax maneuver in the IT industry. (2020). The website of the Ministry of Finance of the RF. Retrieved from: https://minfin.gov.ru/ru/press-center/?id_4=37115-o_nalogovom_manevre_v_it-otrasli.
23. The Decree of the Government of the RF №550. (May 14, 2019). "On approval of the Rules for the provision of subsidies from the federal budget to support projects for the transformation of priority sectors of the economy and social sphere through the implementation of domestic products, services and platform solutions based on "end-to-end" digital technologies".
24. Federal Law dated №115-FZ. (July 21, 2005). "On Concession Agreements". Retrieved from: https://rg.ru/2005/07/26/koncessii-dok.html.
25. Federal Law №224-FZ. (July 13, 2015). "On Public-Private Partnership, Municipal-Private Partnership in the RF and the Amendment of Certain Legislative Acts of the RF". Retrieved from: https://rg.ru/2015/07/17/g4p-dok.html.
26. Federal Law №173-FZ. (July 29, 2018). "On the Amendment of Certain Legislative Acts of the RF". Retrieved from: https://rg.ru/2018/07/04/federalnyzakon-dok.html
27. Federal Law №44-FZ. (April 5, 2013). "On the Contract System in State and Municipal Procurement of Goods, Works and Services". Retrieved from: http://kremlin.ru/acts/bank/37056.
28. The Website of the National Center for Public-Private Partnership. (n.d.). Retrieved from: https://pppcenter.ru/upload/iblock/69c/69c99eeb8cb86ed3598d116a943d8c5c.pdf.