

Perspective directions of the use of smart technologies for the modern urban environment development

E I Dmitrieva

Moscow State University of Civil Engineering, 26, Yaroslavskoye highway, Moscow, 129337, Russia

E-mail: k_dim73@mail.ru

Abstract. The subject of the study is the research of the influence of the modern digital technologies, creating favorable conditions for the qualitatively new level of the population living, on the development of the urban environment. The object of the research is the determination of the perspective directions of the use of smart technologies with of the modern urban environment development. The methods of system analysis of the key directions of the use of digital technologies for the implementation of the "smart city" concept and generalization of various information sources, including analytical data were used during the article preparation. Grouping of the key directions within the implementation of "smart city" concept in the modern economic conditions is result of the research. The conclusion was drawn, that the "smart city" concept will help to achieve such purposes as the improvement of quality of life, decrease in number of offenses, more economical use of resources and so forth.

1. Introduction

The urban environment development in the modern economic conditions represents a rather difficult process in the organization and management of work of not only services of the housing sphere, but also of other sectors of city infrastructure, which are providing comfortable conditions of residence in the city. In turn, it induces the city officials to seek solutions of innovative character to transfer a part of the administrative burden to the digital technologies, which are able to make the municipal economy most automated, and to make the city "smart" [1; 2].

The term "smart city" has a rather wide interpretation, but at the same time the principle meaning in all the definitions refers to the information-and-communication technologies, which provide the current processes of the city life as the result of interaction of the population, business and municipality. Nowadays the management of modern city can and has to be carried out on the basis of the data, arriving from various functional areas of the citizens' activity via video cameras, various sensors, sensors making the basis of the urban environment development [3].

In our opinion, the implementation of the concept of smart city supposes the technological rearmament of the urban environment in which the citizens, surrounded with information services in real-time, ready to pay for their residence in the environmentally friendly and safe quarters and energy efficient houses, using available and fast transport, become the active participants of the management process, improvement and joint use of the property.

As the foreign research proved, the smart technologies belong to the strategic priorities of the innovative development of the leading world economies. Some examples of the successful use of



smart technologies in the "smart city" project can be observed in the following large cities of the world [4; 5; 6]:

1) South Korea, Busan: Busan city administration in partnership with Cisco, five local universities and the city Centre for mobile application development (BMAC) has launched a security and monitoring system, which allows analyzing video images and timely identify problem areas in the management of the city;

2) Spain, Barcelona: the Institute of Informatics of Barcelona has developed the Sentilo platform, which allows different sensor systems at the urban infrastructure objects to exchange data (air temperature, level of loading of Parking space, traffic, etc.). The project is financed through public-private partnership, which includes the government of Barcelona and large companies (IT developers and Telecom operators);

3) Brazil, Rio De Janeiro: the city administration of Rio De Janeiro started the joint project with IBM corporation on the creation of the operational centre, which analyzed information not only on climate change, but also obtained data from all the departments, allowing reacting to emergencies of any type, including crimes and road accident;

4) Great Britain, London: the community Talk London is the Internet portal where discussions and polls of citizens take place to estimate the effectiveness and demand of proposed measures in the development of city infrastructure. In case of registration on the portal data on citizens are collected; that allows inviting, for example, certain national groups to join a discussion.

Thus, the research of modern society gradually passes from the idea of the city as spaces "without time and distances", to studying structural changes of the urban environment under the influence of virtualization of many spheres of life of citizens and also to the description and the analysis daily the experience of the person in the technological developed city.

2. Materials and methods

It should be noted that the modern society is forced to adapt the life to the IT-systems providing clever management, the smart habitat of citizens, clever technologies of the city communications for wellbeing and comfortable stay in megalopolises. However the role of "smart cities" within the transformation of infrastructure image of the modern city is still out of the sphere of the researchers' attention. The need of justification of the effective mechanisms of formation of the new technological urban environment was predetermined by carrying out this research in this direction.

The study of some regularities of the formation and development of the modern urban environment was carried out with the use of the dialectic method, which allowed revealing the main characteristics of the studied phenomena and processes, to define trends of their formation and development.

When studying the actual material method of the expert evaluations was applied; namely the materials of the expert-and-analytical report of the "Northwest" Strategic research Centre [4; 5].

The provided material prove that the Russian projects in the field of smart technologies, used for sustainable development of the urban environment, are implemented only in a few directions, presented in table 1.

The conducted research demonstrates the high-quality transformation and sustainable development of the urban environment which is projected and managed on the base of new technology and social-and-urbanistic level.

Generalizing the studied material, in particular, using the data grouping method, we can expand the directions of use of smart technologies for the modern urban environment development.

One of the important problems of the modern city is the big expense of the electric energy. At the same time the average losses at power supply in the Russian cities are 10-20%. Introduction of digital systems is able to reduce the electricity consumption by 20%, the commercial losses by 95% and the technical losses by 50%. Thanks to such automation the energy-marketing enterprises have the opportunity to reduce their maintenance costs for the inventory and personnel by 10% and also to reach the reduction of the consumers' debts by 50-70% [7].

Table 1. Main directions of realization of smart technologies in the urban environment development

Directions	Field of realization in the urban environment	Examples of the use
1. Services for users	The services providing participation of citizens in forming of the city development agenda act as one of the most dynamically developing segments of the smart city in Russia.	<ul style="list-style-type: none"> ○ Yekaterinburg (complexes of the pedestrian navigation, public transport) ■ "The Best Doctors of Nizhny Novgorod" portal ■ "Crowdsourcing portal", Tula Region. ■ "Active Citizen" portal, Moscow
2. Infrastructure modernization	The projects of intellectualization of separate components of the city infrastructure act as another perspective segment in the field of local solutions.	<ul style="list-style-type: none"> ■ Tyumen (smart crosswalks) ■ Moscow (Wi-Fi in the subway) ■ Samara (clever trams) ■ Krasnogorsk (smart quarter) ■ Moscow (system of the transport navigation)
3. The control system modernization	Creation and development of projects in the field of the effective urban environment management.	<ul style="list-style-type: none"> ○ o St. Petersburg ("Safe City" project) ○ o "Innopolis", Republic of Tatarstan ○ o "SMART City", Kazan ○ o "Innovation Center Youzhny", St. Petersburg

Note:

- *ongoing projects;*
- *implemented project.*

One more common problem of the large cities is the organization of road traffic, convenience and safety of the passenger transport and also the decrease of the accident rate. According to various estimates, the introduction of smart-technologies in transport also helps to reduce the congestion of road infrastructure and the number of accidents, to reduce the cost of maintenance of roads and parking, to reduce the average travel time of citizens to work and backwards [7].

As for ensuring the public security, smart technologies are capable to optimize the work of police: (to increase solvability of crimes and to reduce term of response to incidents; that finally leads to decrease in crime rate in general.

One more direction is the use of BIM technologies (Building Information Modeling) in the construction sphere, which leads to the decrease in cost by 15-20% at the expense of process optimization and the accuracy of the calculations, connected with the materials supply. So, at the initial stage of construction the use of BIM technologies allows saving because of timely elimination of inaccuracies and miscalculations, which are distinguished automatically, and in the medium-term period it provides broad control of the building functioning [7].

Besides we should note such positive effects of use of the smart technologies in the urban environment as the increase in the duration of working ability of the population by 8-15%, the decrease in incidence in the period of epidemics for 5%, the reduction of harmful emissions for 10-15%, the decrease in level of consumption of water by 20-30% and developments of solid waste per capita by 10-20%.

Thus, the competent implementation of digital technologies in the city management (including strategic and territorial planning, programming and budgeting) will make effective resource consumption and also will increase the investment attractiveness of the municipal economy.

3. Results

Nowadays there is no uniform standard of the technologies which active use in the urban environment can designate the city as "smart". Both foreign and domestic analysts point put some general parameters, which presence determines how successfully this or that city implements a project with the use of digital technologies: smart economy, smart transport, smart housing, smart power, smart infrastructure and so forth.

Author believes, that during the use of smart technologies it is necessary to consider the following comprehensive digital solutions for the modern urban environment development:

1. *Online taxi*. Thanks to the advent of electronic services separate services, including taxi, become more convenient and more available to the citizens. As practice proves, the quantity of trips by taxi (Uber or Didi) grew by 30% in Moscow, arrival time of the car to the client was reduced from 30 minutes to 4-5 minutes, and the cost of a trip fell at least by 35%.

2. *Electronic public services*. Integration of the city information portal with the website of public services provides the citizens with the access in the mode of "one window". Those who are interested in using the electronic service can find useful information about the city projects or to learn important news in passing; that makes the use of this portal for the solution of the most different problems possible.

3. *Forming of the information medical system*. Let us list some functions of such systems: resource allocation of the medical organization, queue management of patients in the city scale, challenge of the doctor on the dwelling, tracking of the transition of patients between medical institutions. Such systems also allow providing the interaction with other organizations of the health care system. For example, they allow ordering and paying laboratory analyses or medicines and also performing settlements with the insurance companies.

4. *Use of social networks by the municipality*. Social networks can become the additional communication channel for the city authorities. Let us note some clear advantages:

- the city's account in the social networks helps the city authorities to explain the policy and the taken measures to the inhabitants, and thus the obtained understanding promotes the growth of citizens' trust;
- such accounts provide feedback from the residents in the form of comments, votes and decision making, and also reports about various minor problems;
- such accounts help the inhabitants to learn more about their city (holding various city actions, leisure options). That allows them having more satisfaction from life in general.

5. *Rental housing*. Leasing free rooms or apartments, inhabitants increase the general rate of the city housing stock use. Besides rental housing by its owners is an income source for the local authorities and communities as more affordable prices of placement (in comparison with hotels) promote tourists involvement.

6. *Smart counters and thermostats*. Smart counters function on the base on apps for tracking the resource consumption in real time. That helps the users to understand the consumption pattern better as well as to optimize their payments thanks to the use of resources during the off-peak periods. Smart thermostats present the technology, allowing controlling and program far off temperature indoors via a tablet, a smartphone or a computer. Thermostats are connected to a house heating system, ventilation and air conditionings, they can be operated by Wi-Fi or regulate temperature automatically taking into account a person behavior. Such devices allow cutting power consumption for heating and cooling up to 12-15%.

7. *Online education*. Smart technologies are widely applied in education: from the creation of digital textbooks and holding online examinations up to the development of individual training programmes. The main benefits of online education include its availability. The conditions of entering

include the availability of Internet access and completion of a payment, which it is incomparable lower than the cost of internal rates. The flexible curriculum allows studying at work or during other training. More and more employers recognize the certificates on online education and also use the possibilities of online courses for the employees' development.

8. *Wearable devices for health and sport.* Users can improve their health by the means of wearable devices for health and sport, connected to special platforms or apps. Convenient interfaces allow analyzing data, to make decisions on change of behavior and to choose improving programmes.

According to the features of the city space development the author offers to allocate three typological groups of the cities, implementing various digital decisions for the sustainable development of the environment.

The first and the smallest type can be presented as "high-tech developed". It mainly covers economically developed megalopolises and relies on the highest indicators of material and technical character (GDP per capita and specific weight of Internet users in the total population). In tactical aspect these parameters create some favorable conditions for active implementation of digital decisions for the sustainable urban environment development.

The second group type takes an average position on the quantitative filling and on the qualitative content and therefore it can be defined as "intermediate or moderately developed". This group includes agglomerations (million cities) and the adjacent inhabited territories connected by well-developed transport network and various communications. At the same time the level of the use of digital solutions for the urban environment development in this group is observed less, than in the first cluster.

The third type includes the cities with less than 1 million inhabitants and other settlements which have much worse material and specifications for the use of smart technologies in the development. That allows presenting this cluster as "lagging behind, but strategically perspective" if in the future it is possible to level the lag from more developed city institutions.

For substantial characteristic of the distinguished groups, the author offers some standard models of the urban environment development taking into account the following criteria (Table 2).

Respectively, the main task of the modern city will be the creation of favorable conditions of activity, promoting the city to be "clever". And the effective management of the municipal economy will be determined by the labor cost, the level of the development of technologies and by creativity of the solution of the key problems of the development of the urban environment.

4. Discussion

As the foreign researchers prove, despite the global digitalization, the majority of the population of megalopolises in the world it is not ready to the active life in "the smart cities" yet, despite high rates of introduction of smart technologies to the urban environment [8].

In our opinion, the future residents of "smart cities" will face such problems as the phenomenon of "electronic inequality" (i.e. the impossibility to update gadgets constantly), discontent with the constant observation (24 hours a day) and access to the personal information. Besides, the matter of full transition of citizens to digital carriers disturbs which results in the general restriction of human freedom in respect of manipulation of public opinion in favor of this or that political system. One more obvious threat for modern society is the risk of blackout in case of accident or cyber attacks, which gain strength and popularity more and more actively, representing strong indications of despotism. But it should be noted, that the matters of cyber security, according to the author, have to be solved first of all to prevent the similar attacks and to stop actions of cybercriminals.

It is possible to name two reasons for which the use of smart technologies for the sustainable development of the modern urban environment will continue in the near future:

1) requirement of economical expenditure of resources. Development of digital technologies allows modern megalopolises to get much profit due to the more economical use of the resources, which are available at their order;

Table 2. Standard models of the urban environment development

Criteria of the urban environment development	Technically well-developed type of the urban environment	Moderately developed type of the urban environment	Lagging behind type of development of the urban environment
1. Quantity of city institutions	Megalopolises	Urban agglomerations (cities-millionaires)	Cities with less than 1 million inhabitants and other settlements
2. Extent of the use of digital decisions in the urban environment development	High. Wide scope of all the directions of the population activity for comfortable stay in the territory	Moderate The use only of the significant directions in ensuring comfortable stay of citizens in the territory	Weak The lack of a possibility of the use because of the partial coverage of the territory with smart technologies
3. Demographic aspect	Measures of medical, social, legal character aimed at providing optimum development of demographic processes and improvement of health of the population	Rather favorable conditions for maintenance of natural demographic processes, including education, health care, legal security and so forth.	Low level of demographic indicators, including the assessment of the population health as well as the assessment of the regularities of reproduction, forming the population structure
4. Social-and-economic aspect	Long-term support of the priority directions of social-and-economic development of the territory	The average level of welfare of citizens, allowing using smart technology actively for satisfaction of the interests and requirements, is observed	Low level of the citizens welfare and coverage of the territory with Internet. That affects the general use of smart of technologies for the urban environment development negatively
5. Ecological aspect	Achievements of careful and effective use of any resources with limited or final character	Many enterprises are interested in the increase in the ecological safety of their production, in cost optimization for the nature protection actions. That influences the green infrastructure development	High level of natural resources consumption, implementation of emissions, dumpings into the environment. That has a negative effect on the safe accommodation of citizens in this territory

2) rapid growth of the population of the cities in which about 70% of national economy are concentrated. The quicker the city develops, the more difficult is the control of the large industries and markets. Therefore, the implementation of the "smart city" concept becomes the main tool of the organization and urban governance in large agglomerations.

5. Conclusion

Summing up the research results, it is necessary to point out, that nowadays active participation of citizens in the city life, and management of the city can be carried out with the use of intelligent and information systems on the basis of smart technologies that becomes the main driving force of the "smart cities" development. As the result of these serious and necessary transformations, "smart city" will become attractive to life, it will be included in interregional and international intelligent network, able to use the territorial and resources, potential available to it, most effectively [9].

The implementation of the "smart city" concept will help to achieve such purposes as the improvement of quality of life, decrease in number of offenses, increase in the efficiency of the use of resources, increase in the level of mobility, improvement of ecological level of the environment.

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