“Smart city” concept. Implementation practice

Alisa Vishnivetskaya and Elena Alexandrova

1 Saint Petersburg State University of Architecture and Civil Engineering, Vtoraja Krasnoarmejskaja ul., 4, St. Petersburg, 190005, Russia

* E-mail: vishniv.alisa@yandex.ru

Abstract. Over the past few decades, acceleration of urbanization process in Russia and abroad generated "smart city" concept based on innovative developments integrating into various spheres of urban life. Currently, particular attention is paid to urban environment improvement on the basis of wide information-communication technologies employment. This article is addressing evolution of "smart city" concept and contains analysis of its worldwide implementation in accordance with projects data regarding the degree of their technological and organizational parameters. Results of investigation enabled the authors to reveal obstacles impeding this concept implementation at particular nascent stages, identify factors affecting "smart cities" development, formulate first-priority tasks aiming to eliminate the existing obstacles and propose measures aiming to shape efficient mechanism of "smart cities" development.

1. Introduction

Currently, urbanization processes are more than ever affecting socio-economic development at the level of individual cities, regions, and countries and worldwide as well. More than half of world population resides in cities, furthermore, urbanization process will more likely than not accelerate in future [1]. Urban population growth is leading to problems which the global community had never faced: lack of energy and water resources, air pollution, wastes disposal safety, inadequacy of infrastructure failing to cope with increasing flow of citizens.

Solving of these evolving problems is associated with a complex system of political, social and economic interrelationships inside each city. This is why, beginning from 1990's, attempts were undertaken to form a unified approach on the way of establishing and advanced urban environment reflected in the so-called “Smart City” concept. Despite active employment of “smart city” term, mass media and scientific literature have failed, so far, to find a unified definition thereof. Variety of interpretations, each individually contributing to comprehensive “smart cities” notion forming, allows arguing about complexity and multidimensionality of this term.

“Smart cities” are tools enabling population life quality improvement because development of information-and-communication technologies (ICT) alongside with this concept implementation allows to manage the processes characterizing entire urban infrastructure functioning. Despite the importance of state regulating during “smart city” formation we cannot disregard private companies’ contribution to “smart city” concept development and implementation. Moreover, population participating is also one of the elements enabling this concept improvement. Thus, “smart city” development mechanism is an integrated interaction between various participants of this concept; and
it means that totality of factors affecting the “smart city” concept formation must be taken into account.

2. “Smart city” concept evolution

“Smart city” is normally understood as safe and efficient urban environment based on up-to-date technologies, stimulating consistent economic growth and improving the population living standards [2]. Experts identify population awareness, flexibility of city institutions and strategic character of planning as basic elements on the way of “smart city” creation [3]. Some interpretations [4, 5] proceed from the fact that namely ICT integrating into all spheres of population activities will raise business assertiveness, improve life safety and, therefore, cause sustainable city development. Most generally, “Smart City” is understood as a territory with well-developed economy, modern infrastructure, high living standards and favorable environment [6].

Foreign scientists variously evaluate “smart city” concept formation; however, all of them agree that this kind of project shall be based on the principle of continuous interaction among different structures. It is possible to identify the below listed blocks taking part in “smart cities” creation: organization and control, technologies, economy, management, available infrastructure, environment, population and communities, political aspect [7]. All structural elements comprising the “smart city” concept are interacting between each other and thus manifoldly increase the contribution of each one owing to synergy effect (Figure 1). Nevertheless, ICT is the key factor affecting the “smart city” development; namely, the degree of ICT integration defines “smart cities” classification.

![Figure 1. Model of interaction within the framework of “smart city” [8].](image-url)

The world practice normally identifies three stages of “Smart City” development. First generation of “Smart City 1.0” is the stage which is initiating formation of efficient infrastructure – either from zero (new urban construction) or within the framework of modernization of already existing environment. First stage of development is characterized by technological revamping of the city through modern information technologies implementation. The following is done within “Smart City 1.0”: integrating of centralized systems of transport monitoring and control, electrification and automatization of main railway communications, implementation of power supply control system, establishment of urban services electronic payment systems. In construction sphere: integrating of
CAD-based design technologies. In this case, principal contributors to urban development process are ICT technologies suppliers. Result of first sage of “Smart City” evolution – establishment of semi-automated infrastructure enhancing city stability and manageability.

Next “smart city” development stage – “Smart City 2.0” – is associated with intellectual infrastructure formation; this is achieved through integrating of city automatic traffic control systems and intelligent power transmission systems with load and generation control functions. This stage is characterized by: increase of number of wireless Internet access points, creation of city service platforms. In construction sphere main attention is drawn to buildings energy efficiency and BIM technologies initiation. Namely city authorities are responsible for “smart city” technologies implementation during this stage, while city population is to a smaller degree involved in city management process. Results of “smart city” evolution second stage are improvement of state services quality and resolution of issues regarding transport, public health and ecology.

Third and most advanced stage of “smart city” development – “Smart City 3.0” – is a completely integrated infrastructure using which it is possible to exercise on-line management of all city processes. The following services are being implemented: unmanned vehicle control, off-line technical maintenance. Development of information databases is reaching the higher levels. City population activities performed during this stage of “smart city” development: exchange of ideas, entering information into databases, launching own projects. “Smart city” is expanding beyond its own limits and begins to spread over the suburbs. In Japan, modern technologies enable tracking of crop harvesting in the vicinity of “smart cities” and using this information to balance the flows between city and countryside [9]. In “Smart City 3.0” all resources are subjected to maximum repeated utilization creating the so-called “circular economy”.

Functioning of 3rd generation “smart cities” requires not only improved infrastructure in the form of free Internet, data visualization, use of predictive analytics and consistent ecosystems formation but also requires special investment policy, monitoring of social inequality and keeping up public dialogue [10].

3. Practice of implementation

Let's consider some of existing “smart city” examples with reference to earlier offered classification of such structures. It should not go unnoticed that currently it is possible to simultaneously implement “Smart City 1.0” “Smart City 2.0” and “Smart City 3.0” because development of more advanced system does not exclude advantages of earlier implemented stages.

Judging about "Smart City 1.0" experts often emphasize the experience of Songdo International Business District, South Korea. Idea of this project was conceived in 1990’s, implementation started in 2001 and by now only 70% have been implemented. Total estimated cost of Songdo amounts to 35 billion USD [11]; today's population of the district is about 36 thousand [9]. Songdo was initially based on already well-developed and automated infrastructure. Thus, 95% of car parking places are underground, conditions for e-vehicles employment are being widely spread, e-traffic signs are independently controlling the traffic ensuring that any point can be reached within maximum 15 minutes. A unified resident's card which was established in Songdo enables the holder to use any district facility (metro, parking, bike lease, cinema etc.). Water saving system made enabled 10 times reduction of pure water consumption in comparison with other Korean cities while energy efficient network allowed reducing power consumption by 30% [9]. It is planned to use Songdo "smart city" model in Chinese cities – Changsha, Chongqing and Dalian [12].

Russian “Smart City 1.0” experience is represented by the city of Innopolis, Republic of Tatarstan. This project began in 2010 “from zero” in Kazan suburb in accordance with design offered by “RSP Architects” company, Singapore. As of 2015, total investments reached 20 billion rubles RUR [9]. Scheduled population base is 155 thousand, however, in 2016 number of inhabitants was only 2.5 thousand, although planned population increase rate is 10 thousand [9]; this is why so far it is not possible to call Innopolis a fully functional “smart city”. Main innovations are associated with transport system: leasing of electro mobiles, electric public transport. Innopolis “accessible
administration” principle enables the citizen to discuss city development issues using Internet applications.

“Smart City 2.0” concept which is under implementation in Barcelona, Spain since 2012 allows, within the framework of “Sentilo” platform using 9 thousand sensors to bring together all infrastructure data including environment condition indices. Data collected, owing to highly developed and Wi-Fi network, are in free access, therefore, it is possible to propose city development projects based thereon. Another example of “Smart City 2.0” is Rio-de-Janeiro, Brazil. Here, the city authorities developed (jointly with IBM) weather monitoring system since this region is prone to landslide. In 2011 the system was upgraded to enable forecasting of other emergency situations like criminal wrongdoing and traffic accidents.

In Russian practice namely “Smart City 2.0” is understood as a smart city. In Saint Petersburg, implementation of “smart city” concept is foreseen within the framework of “Strategy of socio-economic development of Saint Petersburg till 2035” [13]. In 2017, “Smart City”- named design office was established to promote regional innovative activities. Development of Saint Petersburg shall be promoted first of all at the expense of innovations in social, transport and engineering infrastructures; economy and management, safety and data bases shall be also built-up with the use of frontier science and technology.

Third stage of “smart cities” evolution – “Smart City 3.0” – is the most advanced concept in which principal attention is paid to citizens participating in urban innovative environment formation. Future “smart cities” of this kind are large cities like London, New-York, Vienna, Moscow etc. “Talk London”, “Listen London”, “Team London”, “London School Atlas” platforms implemented in the city of London enable the population to evaluate political initiatives, offer measures intended to solve matters of concern and to discover accurate predictive information in various spheres of activity owing to continuous data acquisition from citizens by means of ICT mainstreaming. Projects in the sphere of health protection, education, waste disposal, safety based on information collection and monitoring are included in all “Smart City 3.0”. Moscow is on a par with foreign capitals in this respect: “Active citizen” project launched in 2014 was acknowledged as one of the best of its kind; it was awarded “Smart Cities Award” and “Best e-Government Service Award” [9]. Nevertheless, the rest of “smart city” technologies implemented in Moscow are lagging behind the same in the foreign countries, however, population involvement into “smart city” creation from the very first steps distinguishes Russian capital in contrast with other cities.

4. Obstacles for the development
Worldwide practice shows that “smart cities” creation collides with various obstacles impeding concept advancement. “Smart City 1.0” is criticized for commonality of technological solutions applied, scantiness of innovations implementation caused by impossibility to completely transform available infrastructure to meet the new requirements and social inequality growth because living in such cities is inaccessible to entire social groups [14].

There are problems native to all stages of “smart city” development. One of them is a considerable scope of investments at the initial stage of implementation of every new urban environment element. Aiming to lower this obstacle, it is necessary to introduce “smart city” technologies in accordance with mid-term and long-term scheduling documents like strategies and “road maps”. Scheduled parameters may not depend upon political course adhered to by particular city manager because “smart city” is the project which is characterized by long-range implementation period. City authorities also take responsibility for coordination of activities performed by “smart city” innovation suppliers. As a rule, a well-developed “smart city” is using products of companies belonging to various spheres; however, all these companies must have a single target – improvement of urban population living standards rather than pursuing their self-interests.

It is impossible to create “smart city” without state initiative, therefore, state management is an important component of this kind of projects. Creation of “smart cities” is a part of digital economy development process, this is why there are aspects which must be taken into account by the state
authority: clear and realistic goals, strategic scheduling, accounting of earlier experience in digital economy elements implementation, personnel readiness for innovations development, giving consideration to all interested parties opinions including citizens, establishment of specified parameters and their implementation deadlines [15].

Each stage of “smart city” development gains more data about citizens, therefore, access to information (which is more often than not personal) is one of the tasks requiring prompt solution because population unwillingness to shape the “smart city” may immobilize this process. In order to solve this problem it is necessary to continuously improve safe data collection, communication and storage; data encryption technologies must also be improved.

Russian practice of “smart cities” implementation shows that there is a number of obstacles impeding their implementation. Most important problem – lack of system of “smart city” standards, i.e. unified: terminology, requirements, protocols, summarized list of innovations developers and manufacturers. Furthermore, evaluation of efficiency of urban development in direction of “smart city” is often performed by calculation of direct benefits of innovations although it is more expedient to develop and approve the record-keeping system for long-term socio-economic effects [9].

Limited budgets allocated for infrastructure modernization alongside with lacking alternative forms of “smart city” projects financing also impede the process of urban environment improvement. Despite all the aforesaid obstacles, Russia is persistently implementing the “smart city” concept. However, process of national digital platforms development is at the initial stage if compared to foreign countries and this fact dictates that it is required not only improve the regulatory base but to promote innovative activity in general.

5. Conclusions

Worldwide urbanization and ICT development inevitably lead to “smart city” formation. Implementation of “smart city” concept in Russia is facing not only organizational and technological obstacles but the problems of financing either. Currently established RF Program entitled “Digital economy of the Russian Federation” [16] is directly relating to “smart city” development mechanism. Inclusion of “Smart city” project into the aforesaid Program assumes improvement of statutory regulation for digital technologies, development of indices system enabling infrastructure improvement evaluation through ICT implementation and further pilot project implementation within the framework of “smart cites” creation [17]. Despite state regulation measures taken in respect of “smart cities” establishment, projects financing issues require further scrutinizing.

Most evident financing tool to ensure proper “smart city” development – system of direct financial support implemented through subsidizing and granting of advanced technological solutions. Indirect measure of state encouragement is a tax exemption for “smart city” projects and extension of favorable credit facilities within the framework of project implementation. Nevertheless, in current economic conditions it is impossible to efficiently fulfill “smart city” concept without extra-budgetary financial resources. Private-public partnership is one of the tools intended to facilitate this problem solution. Less common way to attract private investors’ financial resources is crowd funding by means of which fund raising by companies and private persons for the purpose of minor innovative initiatives is performed with the use of special platforms. Regulatory support for this tool in Russia is still limited although a number of crowd funding platforms like “Planeta.ru” and “Boomstarter” are working.

Thus, mechanism of “smart city” development must take into account organizational, financial and technological aspects of urban environment innovative development. Statutory regulation of this sphere, transformation of managerial approaches practiced by city authorities, employment of alternative capital mobilization methods and development of information-and-communication technologies – all this enables acceleration of “smart cities” development in Russia and transition from pilot projects to implementation of this concept in various regions on a constant basis.
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