Comprehensive approach to smart urban development based on Big Data application

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Abstract. Despite a certain technological backwardness of the Russian economy, the authors believe that the transition to the «smart city» is possible if one can solve such problems: providing large-scale investment, training and retraining specialists in the field of ICT, increasing innovation managers and consumers, increasing ICT participation in the work of governments, organizations and people, creating the appropriate conditions for the development of the information society. Accordingly, when developing models, it is planned to consider the relationship between quality of life and the existing system of indicators on trends of «smart cities». Monitoring of indicators of quality of life, mutually related indicators of technological development can help us develop the process model. When selecting directions for the main components of the «smart city», let us introduce the evaluation criteria that significantly affect the quality of the values of life. The development of «smart cities» should consider the international experience of the use of breakthrough innovative technology. Research scientists of various countries show a variety of approaches to identifying the main business processes in models of the «smart city». Having the international experience, it is necessary to improve business processes in the construction of a process model «smart city», adapting the model to the characteristics of the national environment.

1. Introduction

Rapid development of information and communication technologies (ICT) triggers the development of new approaches to the search of the key predictors for the success of smart city models and projects. "Smart cities" can be defined as systems that in the framework of the same urban space integrate the subsystems such as smart economy; smart mobility; smart environment; smart people; smart life; and smart management [1, 2].

Smart solutions are developed with the aim to accentuate and consolidate the role of a citizen or resident within smart subsystems as an element of management, since a "smart city" model refers to self-fulfilling systems, where the rights of access in real time to a large amount of information belong to both municipal bodies and city residents.

2. Problem Setting.

It is necessary to draw upon foreign and domestic “smart city” development experience. The study includes the analysis of a number of topical publications dedicated to the development of
smart city projects and models.

Let us divide all approaches into three categories, namely:

a. Study and visualization of the “smart city” development framework. At this stage, the works are of descriptive nature and most often are performed to define abstract architecture. The “smart city” concept is described as a set of initiatives. The difference in the models usually manifests itself in the approaches that differ in the order and sequence of functions performance – it could be either centralized or democratic, “free” distribution of powers (implies involvement of city residents in management). The latter option is an "open" platform that supports the interaction of various applications and access to it for all participants.

b. The studies focus on various interfaces for the collection of data on the residents and municipal services. Such services include the development of various sensors, accumulation of information from social networks and its provision to the bodies of state power and business community.

c. Business models for the representation and construction of a stratified city infrastructure are developed to meet the needs of the residents, including people working in the city and visitors (for example, tourists).

In the structural context, the “smart city” is a system of interacting subsystems. The interaction of a large number of subsystems requires openness and standardization, which are the basic principles of "smart city" development. A “smart city” and a traditional city differ primarily in the nature of interaction with city residents. In a standard city, ICT-based services cannot react to changes in economic, cultural and social conditions with the flexibility comparable to that of “smart city” services. Therefore a smart city is focused on people, based on ICT infrastructure and continuous urban development to ensure environmental and economic sustainability.

Definition of “smart city” should be based on deep understanding of the roles the social relations and human capital play in urban development. In this context, “smart city” is a city where local communities continuously learn, adapt, create and use innovations. This model provides for the involvement of different city residents in social life and encourages them to participate in the management of the city and to change it for the better.

3. Methodology of Research. A comprehensive approach to “smart city” to identify success factors by areas of development

So, the aspects underlying the comprehensive approach to the "smart city" include smart economy, smart (comfortable) environment, smart mobility, smart people, a modern social system, a smart management system, modern technologies, and an innovative energy sector.

This leads to a completely new outlook for city growth and urban development. According to this approach, a city can be defined as "smart" if investments in social and human capital, modern information and communication infrastructures and production technologies entail sustainable economic development, improve quality of life and environment management (through joint management).

"Smart city” projects are based on such basic concepts as quality of life and resource saving. The information model makes it possible to structure all project components at the input and output, applying the system and process approaches simultaneously. The system and process approaches to the development of a “smart city” project are potent tools, depending on the situation, to implement and adapt the most effective innovative technologies, to identify problem areas and to redistribute investments (Figure 1).
IOP Conf. Series: Journal of Physics: Conf. Series 1015 (2018) 042025   doi:10.1088/1742-6596/1015/4/042025

Figure 1. “Smart city” information model

3.1. Methodical Support of Research. Big Data applications in a medium of smart city ultimate goals

Modern technologies can be effectively used to store and process data for obtaining information that can improve various intelligent urban services. In addition, the Big Data approach helps the decision makers to plan any expansion of the services and resources of a smart city. The promotion of services in smart cities requires the tools and methods for effective data analysis. These tools and methods can encourage collaboration and communication between the actors and provision of services to multiple sectors of the smart city as well as improve customer experience and business opportunities [3].

A more careful investigation of the components and participants of the “smart city” network helps to determine the key factors of network framework implementation. Table 1 provides a brief overview of various smart city applications.

Smart Energy System

Rapid spreading of intelligent networks allowed the researchers to integrate, analyze and use data on energy consumption, including consumption in real time, in conjunction with other types of environmental data. In intelligent networks, a large amount of data is generated, for example, from different sources, and measured with widely used smart meters. Higher energy efficiency and improved intelligent services are expected to lead to an increase in the efficiency of investments into an existing infrastructure of intelligent networks.

The effective use of Big Data collected in an intelligent network environment can help the policymakers find a balanced solution adjusted for the energy supply level available for user requirements implementation. Analysis of intelligent network data can also help to predict the need for a power source in the future and achieve strategic goals through specific pricing plans in accordance with the parameters of supplies, demand and production [4].

Smart Healthcare System

Rapid population growth has contributed to rapid changes in healthcare standards; many decisions underlying such changes are based on data collected in the healthcare sector over the past decade. Healthcare professionals can use necessary analytical tools to collect and analyze patient information, which can also be used by insurance agencies and administrative bodies. Moreover, the correct Big Data analysis in the healthcare sector can help predict epidemics, treatment and diseases and improve the quality of life and avoid preventable deaths.

The amount and nature of information accumulated for specific health problems can be enlarged with the help of intelligent gadgets that are linked to homes or clinics to monitor the condition of
patients. In addition, the analysis of large arrays of medical data can help doctors identify signs of a serious illness at an early stage [5].

**Smart Transport**
Information derived from a large amount of traffic data can help improve transport systems in terms of traffic congestion avoidance, alternative routes and identification of the most frequent causes of road accidents.

The data generated by transport systems can also help optimize the movement of goods. Moreover, Big Data collected by intelligent transport systems can help consolidate shipments and optimize transportation by reducing losses in supply chains. Smart transport data can also provide many benefits, such as reduced impact on environment and improved safety, as well as improvement of end-to-end user experience, among many others.

**Smart Management**
Big Data analysis can play an important role in providing smart management [6]. Enterprises with common interests or a similar activity area can be easily identified through data analysis, which will allow them to cooperate with each other. This cooperation can fuel the development of the country as a whole. Moreover, Big Data analysis can help governments develop and implement a satisfactory democratic policy, since they have already familiarized themselves with the needs of people in the areas of healthcare, social aid, education, and so on. In addition, the unemployment ratio can also be reduced by means of the analysis of Big Data of different educational institutions.

| Table 1. Big Data application in the medium of ultimate goals of a smart city |
|---------------------------------------------------------------|
| **Area**          | **Goal**                | **Devices (IoT)**         | **Data exchange technologies** | **Benefit**                                                  | **Limitations**            |
| Smart energy system | Optimizing power consumption | Smart meters              | WiFi, Zigbee, Z-Wave          | - Effective power consumption.                             | High costs; difficult to manage |
| Smart healthcare system | Health monitoring | Sensors, wearable devices | Bluetooth ZigBee              | Early diagnosis of diseases.                               | Lack of accuracy           |
| Smart transport    | Optimization of routes  | Smart cars, cameras, RFID cards | RFID, 3G and 4G               | Traffic management, Routes optimization, Traffic jams reduction. | Problems with communication can provoke a state of emergency |
| Smart management   | Work out an intelligent policy to manage life indicators | Telephones, cameras, sensors | WiFi, LTE, LTE-A, WiMax, Bluetooth, LoRaWAN | - Awareness of the needs of citizens, -Transparent policy | Data collection and analysis is a difficult task. Security |

One of the main conditions for successful construction and implementation of the "smart city" model is the coherence of activities in all areas, including smart economy, smart (comfortable) environment, smart mobility, smart people, modern social system, smart management system and others.

The stages of "smart city" development focused on improving the quality of life can be as follows:

a) To develop a “smart city” process model.

b) To identify subsystems and interrelation uniting the subsystems on the basis of quality-of-life indicators.
c) To develop an expert model for singling out and grouping of statistics according to the needs of a city resident in accordance with the identified subsystems.

d) To carry out questionnaire survey to collect information in social networks to prioritize the needs by groups of urban population.

e) To design a creative model combining data flows obtained by different methods.

f) To develop an algorithm that specifies probabilistic estimates of the discrepancy between data arrays.

g) To prioritize success factors by areas (priorities).

h) To subject to the priorities of the assessments regulating the distribution of investments between the areas of "smart city" development.

The stages under consideration should not contradict each other, on the one hand, and, on the other hand, should complement each other and pursue a single goal - to achieve quality-of-life improvements as indicated by respective benchmarks. Attention should be paid to the importance of effective organization of information flows. It should be sufficient, but not superfluous.

3.2. Modeling Aims and Tasks

Nowadays, the primary task is to create adequate conditions for the development of cities of all types that owing to their increasing competitiveness are capable of ensuring the uniformity of economic and social development of the country's territories. In this process, a crucial role is played by the relations of partnership and mutual assistance based on resource-saving technologies and increasing efficiency of intellectual resources use. Thereby a task of creating conditions for the development of modern cities as intellectual centers can be made a reality.

It is the intellectual capital that plays a decisive role in urban competitiveness. According to some scholars, a city can be defined as "smart" when investments are directed to human and social capital. This is a key to sustainable economic development and high quality of life with a wise management of natural resources through participation of all people involved in the life of the city [5].

The system approach is effective in considering each aspect of a "smart city" framework as a process model at the first stage of the research. For example, "smart medicine" is aimed at improving quality-of-life indicators for each citizen, at increasing human capital and its component, health capital. The process approach is a potent tool for singling out the interrelation between the existing forms of healthcare services provided to residents and the capabilities of healthcare institutions arising with the development of information technologies, creative models, built-in blockchain mechanisms, mobile applications and others.

The collection and processing of a large amount of information on the types of healthcare services (including on-line counseling), healthcare organizations (private and public), specialists, novel approaches and methods of treatment, areas of restorative medicine, and others are not easy. Problems also arise when awareness of citizens is insufficient. In the formation of a competitive environment, when businesses face falling demand and increasing supply, the issues related to the provision of information services come to the forefront.

A process model is a model for continuous monitoring of new methods of and approaches to effective promotion of innovations in the field of quality-of-life improvement. Expert evaluation of the characteristics of the "smart city" constituents reflects the effectiveness of the "smart city" development.

The major task that can be effectively solved with the help of smart city process models is the identification of the interrelation between quality-of-life indicators and major components of "smart city" development, which would contribute to speed-up of the process of improving quality-of-life indicators.

4. Conclusions

The adopted strategy for the development of digital economy leads to a shift in priorities, resetting of goals, objectives and ways to address them, performance indicators by goals and the effectiveness of
their achievement. Classical economic performance indicators are replaced by socially oriented indicators characterizing the transition to the information society that focuses on personal self-
realization.

From the perspective of the national economy and the development of modern cities as intellectual centers, the choice of priorities is based on human capital. Major factors of creating an environment for implementing “smart city” models in Russia include a high level of education, especially in the cities, successful development of open education, virtual mobility of the population, and smart medicine. “Smart city” models should be developed taking into account all research based system and process approaches as well as the principles of self-fulfilling and expert systems.

References
[1] Namiot D E, Chuprynousky V P, Sinyakov S A 2016 Int. J. of Open Information Technologies 4(4) 19
[2] Denisov V V, Kurcheeva G I and Khvorostov V A 2017 Threats to information security in a highly organized system of the "Smart city" Journal of Physics: Conference Series 803 012086
[3] Al-Nuaimi E, Al-Neyadi H, Mohamed N and Al-Jaroodi J 2015 Applications of big data to smart cities Journal of Internet Services and Applications 6(1) 1-15
[4] Kurcheeva G I, Aletdinova A A 2017 The Improvement of business processes based on an information model smart city The Digital economy and industry 4.0: challenges and prospects / proceedings of scientific-practical conference with international participation ed A Babkin (Saint Petersburg: SPhSPU) pp. 69-73
[5] Demirkan H 2013 A smart healthcare systems framework IT Professional 15(5) 38-45
[6] Aletdinova A A, Bakaev M A 2016 The economy of smart and AI-based education The Social Sciences 11(21) 5151-6