Features and Principles of the Formation of «Smart City»

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***Abstract*—The authors consider smart city as a system of a large number of interacting subsystems that require openness and standardization. In a "smart" city, investments in social and human capital, modern information and communication infrastructures and technologies entail sustainable economic development, improving the quality of life and environmental management.**

Keywords—smart cities, business model, quality of life, urban environment, human capital.

I. 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.

In structural context, "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 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.

At the same time, in the demand structure the share of innovations in organizational, economic and social spheres is growing. While recognizing that development of infrastructure for the technological paradigm shift is a principal criterion of innovative development, one cannot help noting a growing role of the society in initiating and successfully implementing the improvements in social development.

The study objective is to highlight “smart city” peculiarities and assess the preparedness of Novosibirsk for the transition to the “smart city” concept.

The methodology of the study includes the following stages:

1) Analysis of the “smart city” concept, justification of the use of digital ecosystem notion in its elaboration,
2) Identification of services and technologies to be used in the “smart city” concept elaboration,
3) Definition of the “smart city” structure for the needs of this study,
4) Analysis of information support from the municipal management system of Novosibirsk (data from the municipal website).

II. ON THE “SMART CITY” CONCEPT

The main goal of developing a "smart city" as a socio-economic system is to improve the quality of life of the population, expressed in increasing the average life expectancy of a person, increasing incomes, quality of nutrition and health, etc. [1]. Experts estimate that by 2020 there will be about 600 "smart" cities in the world, in five years these cities will generate almost two thirds of world GDP [2].

In practice, the “smart city” notion consists of many different components. For example, the International Telecommunications Union highlights only four components: transport, water, energy, and safety [3]. Yu. Shirokov in his works mentions six components: economy knowledge, intellectual mobility, smart life environment, “smart” people, smart lifestyle; intellectual management [4]. The European Community defines 11 priority areas for the European Innovation Partnership on Smart Cities and Communities [5].

The International Standardization Organization (ISO) issued ISO 37120:2014 with “smart city” indicators as follows: Economy, Education, Energy, Environment, Finance, Fire and emergency response, Governance, Health, Recreation, Safety, Shelter, Solid waste, Telecommunications and innovation, Transportation, Urban planning, Water systems and sanitation [6].

These indicators help the cities to evaluate the status and to define measurable progress in their plans over time and subject to necessary resources.

IBM Global Business Services and Plant Location International developed a “smart city” structure with the following clusters:

- Smart Governance
- Smart Economy
- Smart Mobility
- Smart Environment;
- Smart People;
- Smart Living [7].

While comparing different approaches to the “smart city” clustering, it is important to note that “smart cities” have different clusters and common crossing points. A “smart city” is a system in which, depending on the objective of a study, it is possible to outline different subsystems. When considering the structure in less detail it is possible to define seven major subsystems, which allows us to compare “smart cities”. Such subsystems are transport, environment, habitation, energy resources, health, safety and economy.

Analysis of the “smart city” projects implemented in the frames of the “smart city” concept in Kazan and Moscow shows that the minimum of projects were realized in energy sphere and a little more in the sphere of transportation [8].

In modern Russian cities, the level of ICT penetration into social life is increasing (due to both economic and social activities) and the share of electronic management in the interactions between the bodies of municipal power and population is increasing.

III. INFORMATION SUPPORT OF MODERN URBAN DEVELOPMENT

In this study, Novosibirsk is used as an example. Based on the official municipal website, the authors have classified information flows and constructed a process model of city functioning (as is) (Figure 1). The model represents the presence of various business processes run by the bodies of power in the territory of Novosibirsk (there are separate highly specialized departments covering each area of activities and focused on specific tasks (for example, the Department of Transport and Road-Improvement Complex of Novosibirsk) [8].

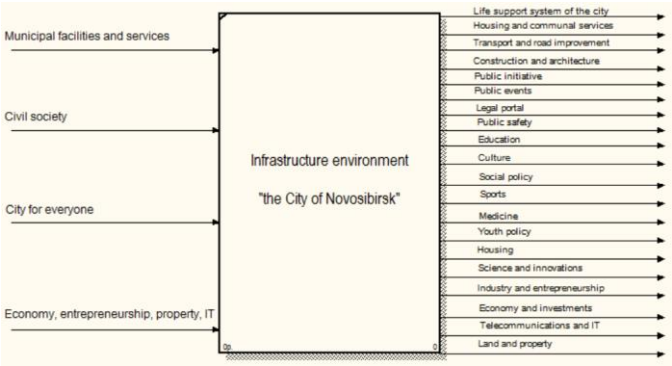

Fig. 1. The existing model of social-economic activities of Novosibirsk («as is»)

Input stream “Municipal facilities and services” represents a complex of enterprises, organizations and institutions situated in the territory of the city and serving the material, cultural and domestic needs of the population. Output streams are:

- Life support system of the city (a complex of municipal rescue and supervisory services);
- Housing and communal services (a complex of the sectors of economy that ensure that settlement infrastructure and buildings are properly functioning and that human habitation is safe, convenient and comfortable by rendering communal public services and a broad spectrum of housing services);
- Transport and road improvement (a complex of services rendered by the Department of Transport and Road-Improvement Complex);
- Construction and architecture (Administration of the Architectural and Building Inspection of the Novosibirsk Municipality).

Input stream “Civil Society” represents the society with developed economic, cultural, legal and political relationships that is independent of the state but interacts with it. The output streams are:

- Public initiative – a proposal of a Russian citizen related to the issues of social and economic development of the country, to the improvement of state and municipal management. PI could be subdivided into federal, regional and local;
- Public event – an open peaceful generally accessible action conducted in the form of gathering, meeting, demonstration, procession or picketing or a combination of said forms conducted by initiative of the citizens of the Russian Federation, political parties and other public associations;
- Legal portal – an element of the state system of legal information made accessible to the citizens;
- Public safety – one of the components of national security expressed through the level of personal, social and state protection from internal threats of generally dangerous nature.

Input stream “City for Everyone” represents direct interaction of the urban society with each resident of Novosibirsk on different social issues and problems. Output streams are:

- Education – Task-specific process of education and upbringing for the benefit of individuals, society and state;
- Culture – a totality of human achievements related to production, society and spiritual life;
- Social Policy – the policy of the state, society, political parties, social institutions in relation to public prosperity, to meeting material, social, intellectual needs of the people and creation of stable environment;
- Sports – creation of the conditions for the development of physical culture and mass sports in Novosibirsk, organization and conduct of official physical culture and sports events in Novosibirsk;
- Medicine – a sector dealing exclusively with medical issues (a list of municipal pharmacies, interpretation of drug provision rules etc.) [9, 10];
- Youth Policy – assistance aimed at the involvement of young people in the social and economic life of Novosibirsk, at

boosting the activities of young people in the solution of municipal problems;

− Housing – provision of housing to the needy residents of Novosibirsk, participation in the organization of municipal housing construction, exercise of other municipal powers pursuant to housing legislation;

− Science and Innovations – providing support to the activities encouraging children and young people to master innovative technologies and defining the major areas of a unified policy in the sphere of innovations in the territory of Novosibirsk.

Input stream "Economy, Entrepreneurship, Property, IT" is a sector dealing with the issues related to the said areas of activity of the population. Its output streams are:

− Industry and entrepreneurship – participation in the development of legal, institutional and economic conditions for the development of science, industry and complex social and economic development of Novosibirsk, including the development and maintenance of favorable conditions for economic activities of the organizations belonging to the scientific-industrial complex;

− Economy and Investments – formulation and implementation of the fundamentals of the economic policy

− pursued by the municipality of Novosibirsk and aimed at sustained social-economic development of Novosibirsk;

− Telecommunications and IT – coordination of the activities on the development of social-economic and organizational conditions for the development and functioning of information and telecommunications services. Definition of the conceptual framework for informatization of Novosibirsk, programs of perspective development of telecommunications in Novosibirsk;

− Land and Property – exerting control over the use of municipal property and urban land, development and implementation of a unified policy in the area of land and property relations.

Table 1 analyzes the municipal portal rendering electronic services.

TABLE 1. NUMBER OF ELECTRONIC SERVICES ON THE LOCAL GOVERNMENT PORTAL OF NOVOSIBIRSK AS OF 25 MARCH 2018 [8]

SN	Heading of the catalogue of electronic service	Number of electronic services provided
1	Interaction with population	2
2	Unified portal of government and municipal services	1
3	Housing and communal services	5
4	Public health	5
5	Property and land relations	6
6	Internet receptions	5
7	Migration system	2
8	Multi-functional Center of the Novosibirsk region	2
9	Tax Service	13
10	Notary Public	1
11	Education	1
12	Pension Fund	2
13	Police	2
14	Post	3
15	Public Prosecutor's Office	2
16	Court Procedure	7
17	Transport	5
18	Transportation means	1
19	Administration of the Federal Bailiffs Service	1
20	Economy	1

From the table it follows that in Novosibirsk electronic services are available not for all output streams of the information model (Fig. 1). As a plus we should note the availability of services enabling the conduct of public opinion polls and questionnaire surveys to evaluate the satisfaction of the citizens with life in their human settlement.

Despite a large number of headings in the electronic service of the municipal site of Novosibirsk, their filling is rather low, on average 3.4 services per heading. There is only one service under six headings; the tax service offers the maximum number of services per heading and it is equal to 13.

"Smart cities" as centers of economy digitization and the problems of their development. The "smart city" information system uses digital platforms integrated into larger digital systems. In our view, the digital assets of a "smart city" will ensure the diffusion of knowledge and technologies, increase the information rate and help to provide the effective management of human settlements based on Big Data application [11, 12].

Currently, the development of a unified digital architecture for the Eurasian Economic Union is underway; therefore, all digital ecosystems shall interact without hindrance with the formation of common sub- and hyper-systems. "Smart cities", in our view, will become the centers for the digitization of economy and public life. Subject to the structure and ongoing integration processes, it is possible to offer a vision of digitization of social and economic activities of Novosibirsk within a "smart city" approach (Fig. 2).

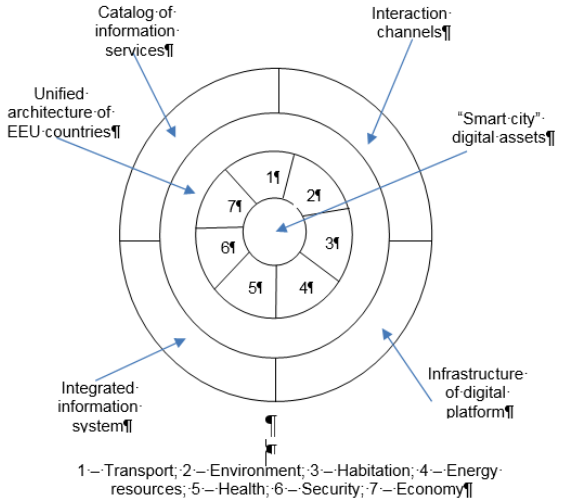

Fig. 2. Model of digitization of the social and economic activity of Novosibirsk within a "smart city" research ("to be")

Transition to the outlined model demands large investments, which is a factor impeding its implementation, although the existing "smart cities" examples demonstrate significant resource savings. Two primary objectives are attainable in such cities – an increase in the quality of life of the population and resource saving. In this connection the demand for specialists capable of providing the digitization of urban life and capable of working in virtual environment will be growing.

A "smart city" is oriented also at the information society sensitive to changes in the sphere of information and telecommunications technologies as well as at socially active population participating in the development of new urban environment.

Besides, at the transition to the "smart city" concept the leaders of settlements, municipal services and consumer organizations will have to perform new functions. We have attempted to identify their primary functions (Table 2).

TABLE 2. NEW FUNCTIONS OF THE SUBJECTS OF THE FUTURE "SMART CITY"

"Smart city" subjects	**Primary functions**
Governing body of the future "smart city"	Correction of the strategy of innovative urban development Municipal services work arrangements related to the transition to "smart city" approach Development of the smart city subsystem integrated with the national and EEU information systems Network interactions based on a digital platform Positioning of an innovative city
Critical municipal services	Implementation of breakthrough technologies and modernization of critical municipal services or infrastructure in accordance with the strategy of innovative city development Development of digital assets and authorization through a catalog of information resources of a common digital platform Advanced training of specialists and recruitment of new specialists with required competencies Network interaction arrangements based on a digital platform
Economic and social entities consuming municipal services	Implementation of breakthrough technologies for the transition to innovative infrastructure and connection to the integrated information system Network interaction arrangements based on a digital platform Creation and placement of proprietary digital assets Training in acquisition of the skills of interaction in digital ecosystems

Only the executives and consumers belonging to the innovative type, which are insufficient in number yet, can perform these functions.

Therefore, based on a new vision of the "smart city" information model of Novosibirsk, it is possible to define basic problems subject to solving during the transition period:

- Non-availability of innovation promotion structure;
- Large capital investments;
- Insufficient number of ICT specialists, executives and consumers of the innovative type;
- Low level of ICT implementation in the governing bodies, organizations and households of the city;
- Slowdown in the rates of information society development.

Development of a "smart city" is impossible without digitization of all interactions, processes and assets, injection into a unified integrated information system, infrastructure modernization and advanced ICT training of specialists and population. Besides, one has to define necessary services and technologies that require improvement.

CONCLUSION

Development of the infrastructure for the shift to the sixth and seventh technological paradigms includes a "smart city" infrastructure among others. Taking into account a growing role of human factors in the development of the new type society corresponding to the seventh technology paradigm, the priority of development of the "smart city" infrastructure providing a new quality of life is growing.

Slowdown in the rates of economic development shall become a stimulus for Russia's transition to a new model of economic development.

Development of scenarios of accelerated transition to the seventh technological paradigm based on its infrastructure development includes, first, inventory of the available approaches to fostering developments of the "smart city" type.

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