

Formation of “Urban planning” indicators for “Smart City” concept (on the example of SKOLKOVO, Moscow)

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Abstract. The development of "Smart Cities" is associated with a comprehensive study of the General system of settlement. The aim of the study is to use the system of indicators for the objective assessment of territories, as well as determining the effect of each part in the overall assessment of the functioning of the «Smart City». The leading method of research is a comparative analysis of international rankings, surveys of experts and a comprehensive study of indicators. The article analyzes the papers of specialists working in the field of research «Smart Cities» and technologies: Mueller, Battarra, Srivastava, Dolgikh etc. The basis for this work were the studies by authoritative rating organizations such as IESE Business School University of Navarra, Vienna University of Technology and Research Institute of technology and communications (NIITC, Russia) which allowed to generalize the available research from the perspective of sustainable development and use them on a concrete example. The authors have adapted the existing groups of indicators in relation to the SKOLKOVO innovation city, Russia. The applied system is represented by 7 groups and 23 indicators, which allow to present the planning aspect of the current urban planning structure with its impact on human capital, transport infrastructure, social cohesion, the state of the environment, etc. The work lets confirm the influence of the selected indicators on the development of SKOLKOVO (Russia) and use the obtained data for the rating of "Smart Cities" adapted for Russia. The materials of the article can be extremely useful in the designing of concepts for the development of territories focused on the use of smart solutions in order to minimize costs in the implementation of new solutions.

1 Introduction

Development of the new generation of the cities – «Smart Cities» – is a phenomenon of the last decades all over the world. The most famous cities of this type are London (UK), Paris (France), New York City (USA), Amsterdam (Netherlands), Barcelona (Spain) and others which excite by their new architectural, technological, ecological and social changes.

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In parallel with renovation of the old cities the new ones such as Songdo (South Korea), Masdar City (United Arab Emirates) are appearing gradually.

The translation of the term «Smart City» in Russian has some variations: like «intelligent» and «reasonable». The difference in interpretation is usually increased by the individual point of view on the phenomenon. The growth of attention to the «Smart City» development is connected with widespread use of electronic media, the introduction of innovative technologies in urban infrastructure etc. Consequently it's often understood that «Smart City» is a settlement full of technologies with some ignoring different aspects of urban life which make cities comfortable in complex. For this reason «Smart City» development needs clear conceptual definition.

The theory and practice of «Smart City» development as a multidisciplinary field is being studied by various specialists under the angle of their professional competence. Experts in technological sphere explore the problems of Big Data Analytics' gathering and integration [14-17].

Some researchers believe that «Smart City» cannot consist of only good infrastructure and sustainable energy supply but also human capital, citizen's input and feedback. Sociologists look how to integrate citizens' ideas and wishes in the urban planning process using crowd sourcing opinions and thoughts of inhabitants through modern information and communication technology (ICT) [5, 9,-13, 21].

Together with the mentioned researches the other part of papers bound «Smart City» concept with urban planning. So Pascual Berrone insists that logistics, transport expenses, travel time, human capital, investment activity and more are all dependent on this parameter. In this regard the new approach to smart urban planning should be aimed on compact cities, well-connected within and among themselves with convenient access for citizens to all public services. E. Dolgikh traces the relationships between «Smart City» concept and sustainable development insisting that it is unreasonable to manage the city without «sustainability» because any taken decision should consider social, economic and environmental favour both in a short and in a long term. A general goal of smart cities is to improve sustainability with help of technologies but not only implement new technologies what transforms the idea of «Smart City» into a branding hoax [1, 3, 6, 19, 20].

Smart urban planning has got lots of common issues with the «green» approach, for instance in improvement of inhabitant's comfort. Compact urban form may contribute to the reduction of electricity demand from the residential sector [1, 16, 18, 22].

Despite the large amount of existing surveys the scope of interdependence of urban planning and the concept of «Smart City» is not worked on enough. The area of interdependence between urban planning and the «Smart City» concept implies further research. The paper is aimed to define the system of «Smart City» indicators related to urban planning criteria in application to Russian conditions (using SKOLKOVO experience). In order to achieve the goal, various «Smart City» indicators identified as significant in the rating studies of authoritative foreign and domestic authors were analyzed and compared carefully. A survey of a group of Russian experts was conducted in order to confirm the importance of urban planning parameters in the «Smart City» concept. Own research which allowed to allocate the most important indicators connected with urban planning is conducted, adapted to the Russian conditions and applied into the SKOLKOVO innovation center (Moscow, Russia) systematically.

Methods of the research are: complex analysis, survey of experts, comparison, grouping and comparison of «Smart Cities» ratings.

2 Materials and methods

For selection of cities and definition of the most complete compliance of the "Smart Cities" concept are usually used ratings and indexes. They allow evaluating, comparing and classifying dissimilar options to be more objective.

One of the most respectful work with a wide geographical coverage is IESE «Cities in Motion» (CIMI, by IESE Business School University of Navarra). It includes 180 cities representing 80 countries. For calculating the index 79 indicators has been included. One of the key dimensions (group of indicators) is "Urban planning". The others are as follows: the economy, technology, human capital, social cohesion, international outreach, the environment, mobility and transportation, public administration and governance (Figure 1).

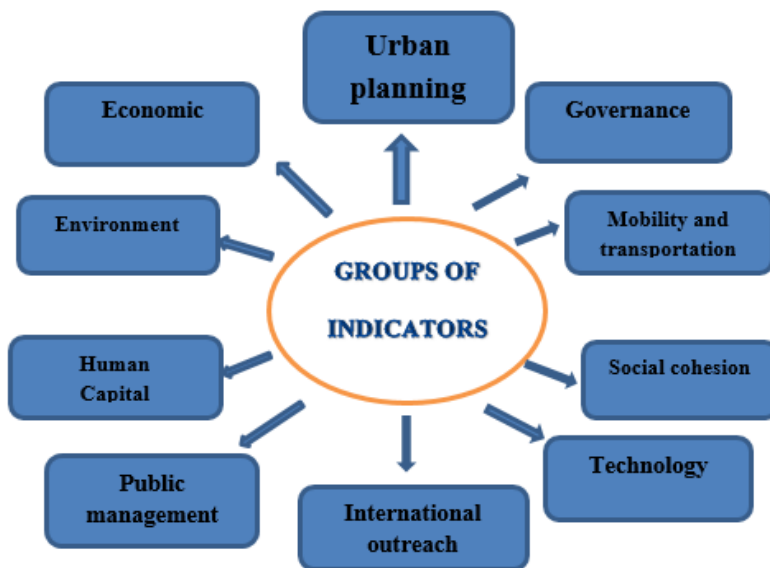


Fig. 1. Groups of indicators presented by IESE «Cities in Motion» index (IESE Business School University of Navarra).

For demonstrativeness of the work the 10 world leading cities in 2017 are presented in the Table 1. It's important that 8 cities from the list are European. World leaders are New York (U.S.), London (U.K.) and Paris (France). Herewith Amsterdam is in the top 10 (#10) in «Total results» column and #1 in a column of «Urban planning» group (almost all inhabitants have got appropriate sanitation facilities and low density per household) [3].

Table 1. Results of IESE «Cities in Motion» index 2017 (IESE Business School University of Navarra).

City	Country	Position	
		Total results	Urban planning
Amsterdam	Netherlands	10	1
Suzhou	China	Not in the top-10	2
Oslo	Norway	Not in the top-10	3
Geneva	Switzerland	Not in the top-10	4
New York City	USA	1	5
Warsaw	Poland	Not in the top-10	6
Berlin	Germany	9	7
Paris	France	3	8
Rotterdam	Netherlands	Not in the top-10	9
Wroclaw	Poland	Not in the top-10	10

London	United Kingdom	2	Not in the top-10
Boston	USA	4	Not in the top-10
San Francisco	USA	5	Not in the top-10
Washington, D.C.	USA	6	Not in the top-10
Seoul	South Korea	7	Not in the top-10
Tokyo	Japan	8	Not in the top-10

As it can be seen from Table 1, the total column "Urban planning" (Amsterdam, Suzhou, Oslo, Geneva, New York city etc.) and the leading cities in the overall standings (New York city, London, Paris, Boston, San Francisco New York city) do not match.

In the "European Smart Cities" rating (by Vienna University of Technology, 2014) the model of «Smart City» is analyzed from the standpoint of building cities on the interconnectedness of the six key groups of indicators such as: Smart Economy, Smart Mobility, Smart Environment, Smart people, Smart Living, Smart Governance. 77 European medium-sized cities with the population from 100 to 500 thousand people (with 1 University and not being in the zone of influence of large cities) were accepted in the rating results. According to the rating, the top three cities look like this: Luxembourg (Luxembourg), Aarhus (Denmark), Umea (Sweden) [4].

Rating "Indicators of smart cities NIITS 2017" (by Research Institute of technology and communications) is the only Russian study in this area. In it the authors considered 16 cities of the Russian Federation: Moscow, St.-Petersburg, Yekaterinburg, Novosibirsk, Samara, Omsk, Chelyabinsk, Kazan, Novgorod, Volgograd, Voronezh, Perm, Krasnoyarsk, Ufa, Rostov-on-Don, Sochi.

There were identified seven main areas of a «Smart City»: economy, administration, inhabitants, technology, environment, infrastructure, finance. Russian authors used in their comparison 26 indicators and harmonized them with the indicators used by foreign research centers (standard EC/ISO Joint Technical Committee 1). According to the degree of «smart technologies» implementation the leaders were Moscow, St. Petersburg, Kazan[2].

Despite the credibility of the presented researches, the authors conducted their own study in the fall of 2017 to analyze Urban planning indicators. The basis was the study of Navarra business school with 10 main groups of parameters due to the representation of the widest coverage of indicators. From all groups of parameters the authors identified those associated with Urban planning including Urban planning group of indicators as well as indicators given from different groups but also connected with urban planning in effect.

Let us review them in details. «Human Capital» (number of business schools, universities, museums, art galleries, expenditure on leisure and recreation) obviously bounded with urban planning but not limited to only planning. «Health index» from dimension «Social cohesion» also has a relationship with the planning: in particular, health may depend on the presence or absence of nearby housing hazardous industries, the loaded highways, location of city dumps, etc. that affect the human condition and the duration of one's life. The indicator is closely intertwined with the «Environmental indicators» group with percentage of the population with access to the water supply, environmental performance index, pollution index parameters. «Mobility and transportation» dimension is joined to urban planning as well and like in other cases not limited to urban planning only. Means of transportation, forms of public transport, pedestrian access to the social infrastructure etc. are all envisaged at the stage of urban planning. In «International outreach indicators» group the «Number of hotels» and indicator of visual characteristics of the city «Sightsmap» are related to urban planning.

To confirm the impact of urban planning indicators on the formation of the «Smart City», a survey was conducted among 34 Moscow experts engaged in territorial planning or directly related to planning. The composition of the survey participants is presented in Figure 2A.

A

B

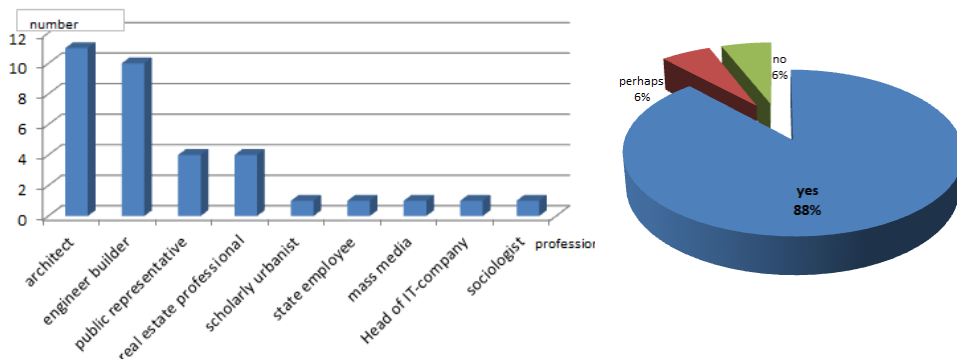


Fig. 2. Survey. A - Professional composition of the participants. B - Poll results.

Most experts (88 %) indicated that urban development issues have a significant impact on the overall concept of "«Smart City»", 6 % of survey participants responded "perhaps" and 6% believe that there is no relationship (Fig. 2B).

Practical confirmation of the theoretical part of the study is the research of innograd SKOLKOVO in terms of urban and planning development.

3 Results

The SKOLKOVO innovation city is located in the territory of 4.000,000 m in close proximity (1.5 km) from MKAD. In 2012 the territory has been joined to Moscow (Mozhaysk district, ZAO) though SKOLKOVO has got an informal status of a "city within a city" being built on previously inhabited areas. It is expected that all in all there will be living 20 000 citizens and 30 000 can be guests by 2020. As of January, 2018, the first 3 residential facilities are settled with a total population of about 1000 people.

SKOLKOVO can be accessed from the Minsk and SKOLKOVO highways, while the Kiev motorway passes close by and the Trekhgorka train station is located closely, from where there are trains to Moscow’s central Belarussky station. A multimodal transport hub from the direction of the Minsk highway links the main transport thoroughfares with the main entrance to the innovation city [8]. Project has started in 2010. Its urban planners (Architectural bureau AREP with the involvement SETEC Engineering and landscape architect Michel Devigne) have been focused on the achieving the parameters as follows:

- to use the features of the site and landscape as a natural frame of the city;
- to create opportunities for fruitful interaction of people, knowledge, research and business institutions, which is the basis matrix of the innovation;
- to ensure a high quality of life based on respecting the principles of sustainable development

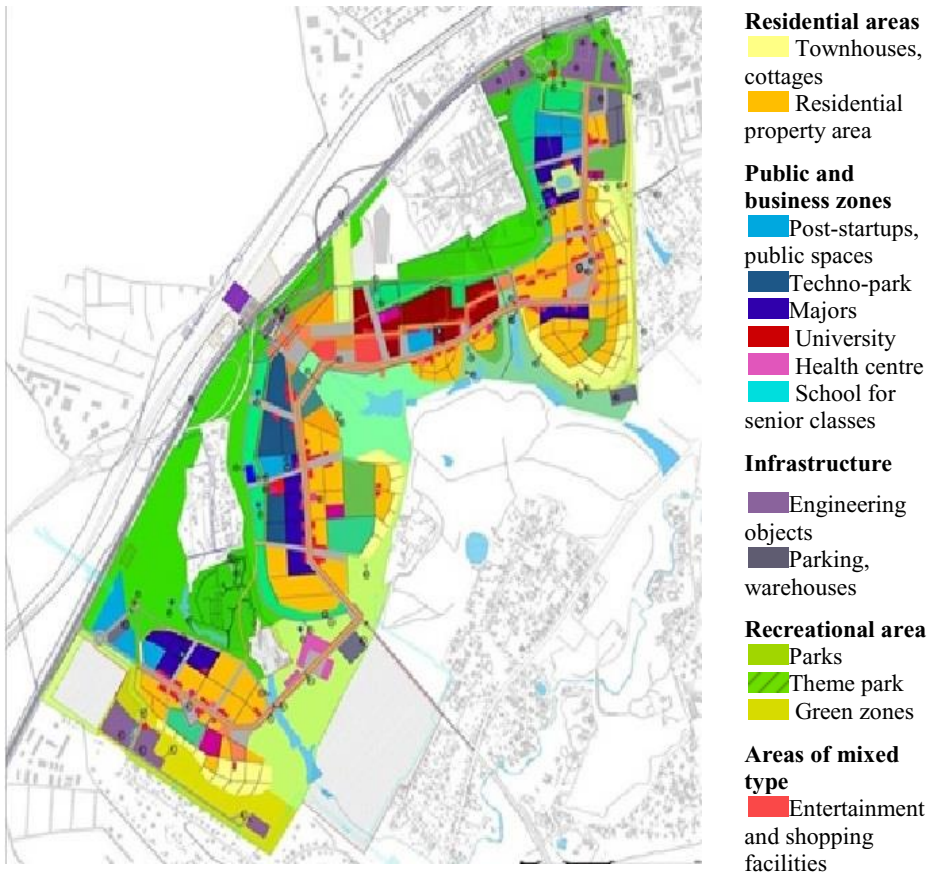


Fig. 4. Master plan of SKOLKOVO with zones indicated [8].

SKOLKOVO master plan (Figure 4) is formed as a chain of related compact areas, with everything necessary for life and work in each one (mixed-use zones). The linking transparent and conceptual axis is the Central Boulevard, which passes through all the districts. The city has been planned with a network of parks and other public spaces. [8]. Cultural life is concentrated in the University, where lectures, seminars and various workshops are held. The location of the city near the Minsk highway has a negative environmental effect. In order to reduce its impact space between the track and the residential area is occupied by Golf courses. Large planar infrastructure facilities are weakening the impact of noise. In addition planning allows you to pre-allocate energy capacity. There is a central zone formed around the main square, connected to the main transport terminal. It's supposed to build a Congress center, hotels, cultural institutions and other socially important facilities. The campus of SKOLKOVO Institute of science and technology and Technopark is nearby. Each of the five districts has office and residential buildings. Along the Boulevard there are blocks of a mixed type: offices for large and small companies, housing, service companies, places of rest and communication. Low-rise dense construction creates a comfortable, rich and aesthetically attractive urban environment. The engineering and transport infrastructure laid down in the master plan proceed from the requirement to provide long-term sustainable development of the territory without growth of resources' consumption [8].

Table 2. SKOLKOVO indicators which determine the relationship between the concept of «Smart City» and urban planning.

Comments	(in future)	(at presence)	Indicator	Groups
Moscow School of Management	1	1	Business schools	Human Capital
Skoltech University will be open in 2018	is being build	1	Number of universities	
Technological museum to 2025	No*	1	Museums	
To 2025	No	10	Art galleries	Social cohesion
2,000,000 sq.m	is being build	50% of territory	Expenditure on recreation	
Public zones inside and outside			Means of communication	Environmental indicators
All sites has access to the water supply	100%	100%	Access with the water supply	
50% territory of the city is supposed to be	No data	No data	Pollution index	Mobility and transportation indicators
4 routes of public transportation. Compact city for easy walking	Pedestrian city. Public transportation	10 bus routes	Traffic	
About 10 per year	No data	10	Traffic accidents	
no data	No	No	Metro	
Belarusian direction of the Moscow	2	2	Railway stations	
No data	Vnukovo airport	Vnukovo airport	Flights	
No data	vehicles, route taxis, etc.	Construction machinery, taxis, buses, etc.	Means of transportation	
Every parking is for 10 bicycles	No data	6 bicycle parkings	Bike sharing	
100%	100%	100%	Access to sanitation facilities	
Couples without children or with 1 baby	No data	2,3	The coefficient of family	
Insufficient number of inhabitants to open	possible	No	Bicycle shops	Urban planning indicators
50 architectural bureaus worked at the city	No data	50 architectural bureaus	Architects	
Pedestrian city	No data	10%	Cycling	Technology indicators
20 kVA; 250 MW per 20,000 residents	100%	is being build	Energy security	
Not in the plan	No data	No	Hotels	
Number of photos taken in the city. No data	No data	No	Sightsmap	International outreach

As it was mentioned in the «Methods and research» part of the paper, the indicator groups from «Cities in Motion» study related to urban planning are taken as a basis. The authors adapted them for the urban settlement SKOLKOVO. There were analyzed 23 parameters from 6 groups of indicators, actual and perspective state were considered (Table.2).

Despite the lack of some data, which are mandatory for the study "Cities in Motion", the authors used prospective data (for example, the construction of the University by 2025). Some indicators were replaced. Thus in the group "Social cohesion" the authors offered such indicator as "Means of communication" instead of the original indicators; in the group "Mobility and transportation" the indicator «Railway stations» was added; in «Urban planning» the indicator "Bicycle sharing" was joined to the group. As well as the indicator "Energy security", relevant for the period of active operation and providing power grid data, was inserted into the "Technology indicators" group. Some parameters have no data and difficult to find its substitute but due to the fact of their importance the authors left them in the table.

4 Discussion

The city planning SKOLKOVO idea is the largest attempt in the history of new Russia to launch a "factory for the production of innovative technologies". For comparison, in the 30-IES of XX century the government of the USSR attempted to build a "garden city" Prominent in the Moscow region with the city-forming coke and gas plant. The place was chosen also near the capital. Basic architectural and planning principles were close to those laid down in SKOLKOVO: the placement of comfortable housing for workers near the production. When designing the district, it was planned to build a school, a kindergarten and a nursery, an administrative building, shops and a simple sports complex. However, over time, there was a contradiction in the development of the city, associated on the one hand, with the presence of green areas, and on the other hand with the environmentally unfavorable neighborhood with the city forming enterprise. The factor of environmental friendliness associated with the innovative nature of SKOLKOVO let us make a favorable forecast regarding its further development.

5 Conclusions

1. When considering Russian cities belonging to "Smart Cities", the absence of a number of statistical materials is not an obstacle to the analysis. It is proposed to use the existing data compensating (replacing) the lack by taking into account the key groups of «Smart City» parameters, which are commonly used in reputable foreign rankings.
2. The existing Russian experience shows that it is necessary to create a national methodology for determining «Smart City» indicators in cooperation with urban planning parameters, taking into account the individual character of each city, which will allow making the most effective and balanced decisions.
3. The innovative city of SKOLKOVO (Moscow, Russia) takes into account planning aspects that allow to manage the territory effectively by creating new technologies at the stage of designing the city.

The significance of the work is related to the state programs aimed at the renovation of Moscow in 2018-2022 (redevelopment of individual neighbourhoods and their integration into existing urban development), taking into account the existing concept of "Smart City" mostly connected with urban management); "Strategy for the development of the information society in Russia for 2017-2030"; "Formation of a comfortable urban environment" and "Digital economy of Russia".

Further research will focus on:

- collection of information, its systematization, clarification with the aim to create Russian methodology of «Smart City» indicators, taking into account urban planning aspects, on the basis of a comprehensive analysis;
- rating of the most comfortable territories of the Russian Federation taking into account the «Smart City» concept;
- analysis of the most effective planning solutions for the integration of renovation areas in the existing urban development;
- formation of recommendations for the General plans of territories taking into account the concept of «Smart City».

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