CONTEMPORARY TECHNOLOGIES AND SMART CITY CONCEPT SYSTEMS IN THE CZECH REPUBLIC

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ABSTRACT
The concept of smart city has spread throughout the world over the past few years. Smart City is a concept that uses digital, information and communication technologies to improve the quality of life in cities. It focuses on the effective use of existing and search for new resources, reducing energy consumption, eliminating environmental burdens, optimizing traffic and sharing data for public purposes. To make cities smart, they are increasingly investing in modern technological measures. There is no uniform guide for all cities on how to achieve this. Each city is unique and has its own problems to deal with by combining different measures. It is difficult to assess which city in the world is actually the smartest one at the moment. The aim of the paper is to map information technologies planned and used in selected cities in the Czech Republic. The secondary aim of the paper is to answer the question, what is the ranking of selected city in the Czech Republic compared to other foreign countries. The methodology of this paper is based on a comparison of published Czech and international studies. Discussion of this paper deals with the current changes and needs of city dwellers in the smart city concept and a comparison with foreign concepts of smart city. The paper tries to emphasize the need to follow new trends, smart city technology. The paper presents a new perspective and recommendations for the use of the smart city concept in cities.

Keywords: *smart city, technology, innovation culture, productivity.*

1 INTRODUCTION

On average, one in five people lived in cities one hundred years ago, today it is more than half the world's population. According to OSN, by 2050 about seven out of ten people on the planet will live in the city (World Urbanization Prospects, 2018). But as the population grows, it is becoming increasingly difficult for large cities to remain a truly quality place to live. For the cities, more people are more demanding on transport and energy, more water consumption or, for example, waste generation. Cities have to undergo a major transformation in order to bear this onslaught - modern technology and the Internet. Just as a few years ago ordinary cell phones became smart phones, they would become intelligent buildings (Velux - Healthy Buildings Day, 2016).

Smart Cities Concept (Smart Cities Concept) means the following (MMR, 2015):

- the road to sustainable urban development;

- the introduction of modern technologies in city management to improve the quality of life and streamline governance;

- the greatest application of the concept - in the field of transport, energy and the introduction of modern information and communication technologies (ICT);

- use in other areas such as waste management, water management, e-government and crisis management;
- Smart Cities concept a gradual process not a state.

The concept of smart city has spread throughout the world over the past few years. To make cities smart, more and more money is investing in modern technology. (Slavík, 2017) According to an analysis by Deloitte, they will invest around $ 1.5 trillion globally by 2020 alone. (Deliotte - Smart Cities Report, 2015) Most of the money will flow into energy, IT and transport (Frost & Sullivan, 2018).

The three main benefits of Smart City are:

- increasing the quality of life, reducing energy intensity, saving mandatory costs or increasing management efficiency;
- solving problematic issues in cities;
- interconnection, harmonization and synergy.

Smart City (SC) is one of the concepts of applying the principles of sustainable development to the organization of the city, which is based on the use of modern technologies to improve the quality of life and streamline governance. There are several Smart City components with the result of an intelligent city, see Fig. 1. This concept is most widely used in the field of energy and in the field of transport, which can be more effectively addressed by the deployment of appropriate information and communication technologies (ICT). However, the Smart City concept does not only cover the two areas mentioned above, but can also be applied to others, such as water management, waste management, e-government or crisis management.

Fig. 1 shows an intelligent city framework with 16 hierarchically arranged components. Each higher whole (A, B, C, D) consists of four hierarchically arranged components from basic to complex (1, 2, 3, 4), whose order is connected in sequence. The overall concept then represents a process for creating an intelligent city and any project requiring public support should, if relevant, fulfill all 16 components. (MMR, 2015)
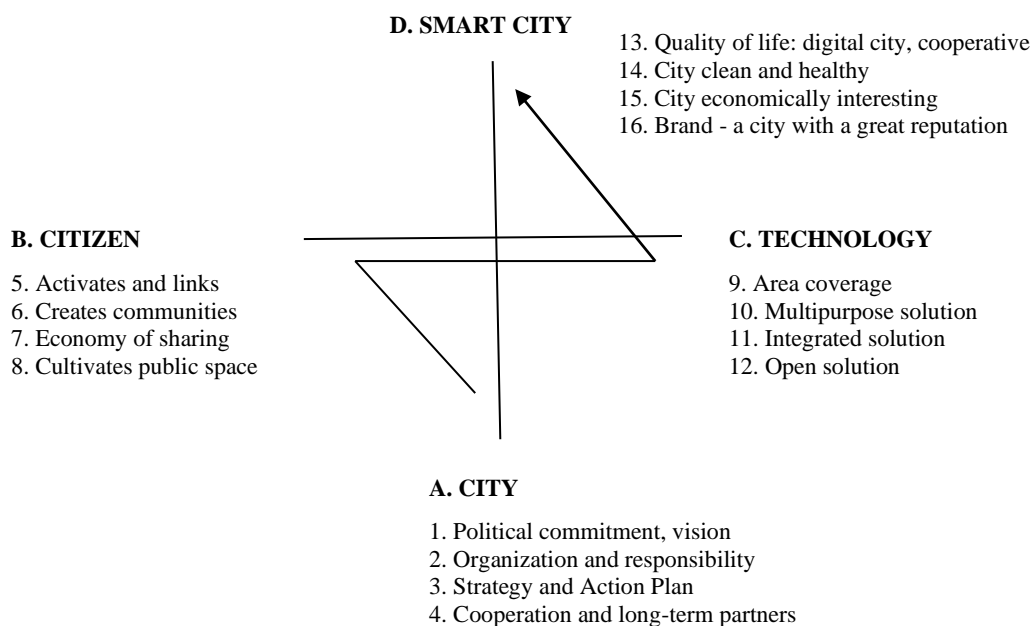
D. SMART CITY

13. Quality of life: digital city, cooperative
14. City clean and healthy
15. City economically interesting
16. Brand - a city with a great reputation

B. CITIZEN

5. Activates and links
6. Creates communities
7. Economy of sharing
8. Cultivates public space

C. TECHNOLOGY

9. Area coverage
10. Multipurpose solution
11. Integrated solution
12. Open solution

A. CITY

1. Political commitment, vision
2. Organization and responsibility
3. Strategy and Action Plan
4. Cooperation and long-term partners

Figure 1: Intelligent City Framework with 16 hierarchical components (MMR, 2015)

The SC concept is a program change led by the political representation of the city and is a gradual process, not a state. In contrast to conventional planning and operation of Smart City agendas, it simplifies the process of engaging the professional and general public using electronic tools (eg communication platforms or social networks). It provides the possibility that the city's strategies are not made up solely of a skilled supplier in cooperation with the city's department, but of working groups made up of experts from various institutions, local entrepreneurs and interest groups that the city effectively coordinates using electronic media. The resulting strategies can then be submitted for comments in electronic public fora and then discussed with the public at open meetings so that the introduction of their final form is generally accepted by the citizens, while at the same time reflecting as many ideas and ideas as possible. Such action also anticipates prudent investment in new technologies to support these new programs, which has an impact on the investment but, above all, on the operating costs associated with the technology.

2 RESEARCH METHODOLOGY

The primary aim of the paper is to map information technologies planned and used in selected cities in the Czech Republic. The secondary aim of the paper is to answer the question, what is the ranking of selected city in the Czech Republic compared to other foreign countries. The methodology of this paper is based on a comparison of published Czech and international studies and researches.

Five cities were selected to map the information technologies of the Smart City concept. According to the population categories set by the Ministry for Regional Development in the Czech Republic, cities from categories A, B, C and D were selected, as shown in Tab. 1.

Table 1: Category by city population (MMR, 2015)

Category	Population of the city
A	over 150000
B	40000-150000
C	15000 - 40000
D	5000 - 15000
E1	1000 - 5000
E2	up to 1000

The following hypotheses have been defined:

$H_0 1$: Only large cities implement Smart City technologies with a population of over 150,000 that fall into categories A and B.

$H_1 1$: Smart City technologies are implemented by cities with a population of less than 150,000 that fall into categories C or D.

$H_0 2$: Prague will rank among the top 100 cities out of 147 Smart City rated cities.

$H_1 2$: Prague is not one of the top 100 cities out of 147 Smart City rated cities.

3 RESULTS OF THE RESEARCH

Tab. 2 shows the results of the research aimed at mapping the technologies of the Smart City concept in selected cities in the Czech Republic. Prague, as the capital of the Czech Republic, was selected for category A. Pardubice was selected from category B, Písek and Litoměřice were selected from category C, Vrchlabí belongs to category D. The results show both current and planned technologies in the Smart City concept for selected cities. Specific Smart City manuals published by selected cities are also listed.

The first research hypothesis H_01 is rejected. Is valid hypothesis H_11 research - Smart City technology has been implemented not only by cities in categories A and B, but also by cities in categories C and D. The Smart City concept is used by cities below 150,000 inhabitants, as shown in Tab. 2.

Table 2: Current/future technology of Smart City concept selected cities in the Czech Republic (Own calculation by IPR Prague, 2015; Smart City Strategy of the City of Pardubice, 2017; SmartPlan Písek, 2015; Strategic development plan of the town of Litoměřice, 2012; Smart region Vrchlabí, 2010)

City in the Czech Republic	Category	Population	Current technology of Smart City concept	Future technology of Smart City concept	Manual
Prague	A	1 281 000	Mobile app to increase tourism	7 pilot projects	Smart Cities a Morgenstadt: City Lab (IPR)
			Electric vehicle charging station	Increase charging stations for electric vehicles (100)	
			Ecological transport - discounted parking, electric cars, bikesharing		
Pardubice	B	90 688	Transport - application for booking a place in cycling stands	Smart Parking and mobile app for Smart Parking	Smart City Strategy of the City of Pardubice
			Bikesharing and Biketowers	Traffic jam warning system	
			Energy dispatching - reports to the city current energy consumption or network breakdowns	Energy self-sufficient public lighting	
Písek	C	30 351	Flow rate and water pressure monitoring system	Pillar "Intelligent Mobility", "Intelligent Energy and Services", "Integrated Infrastructures and ICT"	„Modrožlutá kniha Smart Písek 2015"
Litoměřice	C	24 000	Reconstruction in low-energy or passive buildings with minimum energy requirements	Reduce energy consumption by one fifth by 2030	Energy management
Vrchlabí	D	12461	Charging stations for electric vehicles and cogeneration units	Energy savings in buildings	Project Grid4EU Smart region Vrchlabí
			Modernization of the distribution network		

Prague was chosen as the capital of the Czech Republic for secondary research. The following 9 research criteria were chosen as key criteria in the evaluation of the Smart City concept:

- Technology
- Economy
- Governance

- Mobility and Transportation

- Environment

- Urban planning

- International outreach

- Human capital

- Social cohesion

Research results are drawn from Index Cities in Motion 2019, which evaluates 174 cities on a 200 point scale, the higher the score, the better the city meets the Smart City concept. (IESE, 2019) The following Fig. 2 shows selected indicators that assess the selected city from the perspective of Smart City approach. Overall, Prague ranked 47th out of 174 countries being compared. Therefore, the null hypothesis $H_0 2$ is valid and hypothesis $H_1 2$ is rejected. Prague is rank among the top 100 cities out of 147 Smart City rated cities.
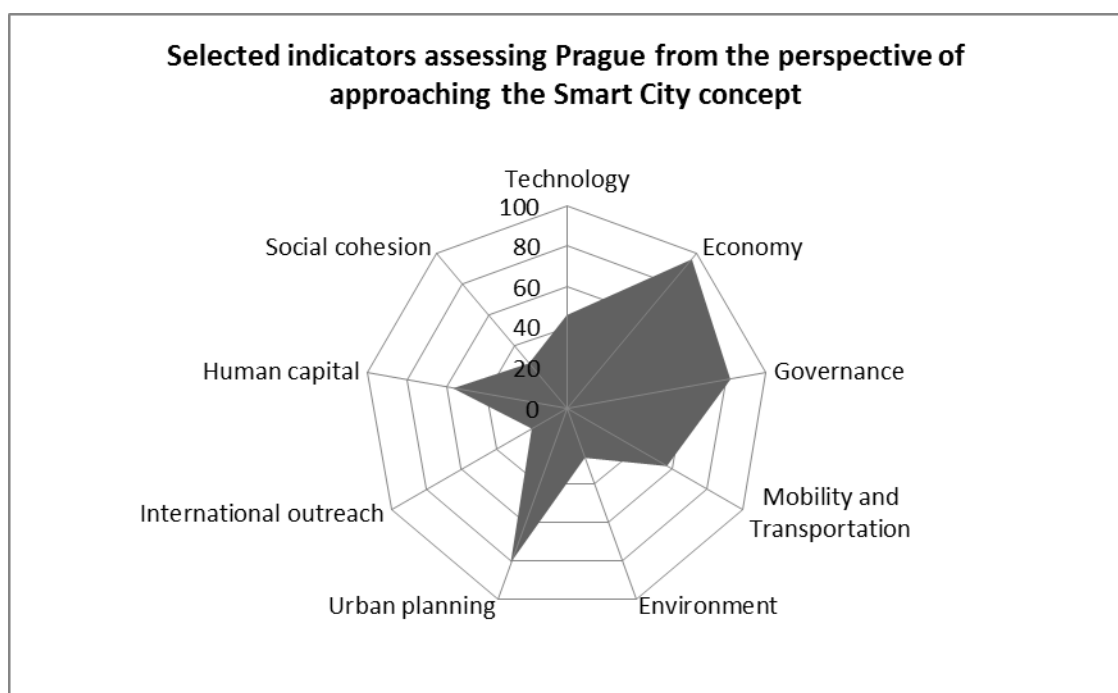

Figure 2: Prague - comparison of selected Smart City indicators (Own calculation by IESE, 2019)

Smart City's first selected indicator is technology that includes smart devices connected to the Internet. This is not just about telephones, but monitoring how cities are in terms of the number of places where you can connect to free wi-fi, or how popular the city is on social networks. Prague has a lot to improve, but the technology is still not very efficient (46 points).

Another indicator is the economy, because cities that can manage well and support business can grow faster. The main indicators of this criterion include labor productivity, GDP or, for example, the number of large international companies that have their registered offices in the city. Prague ranked with a total of 96 points.

Regarding another indicator of city management, Prague ranked only 82 points in this category. The main prerequisites for a high government rating are low corruption, good communication with the population, publication of contracts and important documents.

A dense public transport network and high-quality road infrastructure without columns guarantee fast urban transport. The advantage is the availability of metro or busy airport. For this reason, Prague rakned 57 points.

A quality environment makes the city a good place to live. Of particular importance in this respect is the emphasis on clean air and efficient use of water. High in the ranking are cities that seek to reduce the amount of dirt produced by buildings and cars. Prague randked 26 points.

Public space planning can save cities a lot of money by building additional infrastructure and strengthening public transport. It is important that the city does not expand too much and that residents have shops and other services near their homes. Prague has improved significantly in this area in recent years and ranked 81 points.

Cities that want to prosper should strive to be popular abroad. It is relations with foreign countries that bring interesting opportunities. Important is therefore good marketing and promotion of the city brand, organizing international congresses and last but not least attracting foreign tourists. Thanks to its history, Prague is popular abroad and ranked 20 points.

For building a smart city is the most important potential of the people themselves. Cities with a high number of university students, but also trained professionals with practical skills have an advantage. In addition to the number of university educated people, this category also includes the number of universities, museums and art galleries. Prague ranks with 57 points.

Social cohesion in the urban context refers to the level of coexistence among groups of people with different incomes, cultures, ages, and professions who live in a city. Concern about the city's social setting requires an analysis of factors such as immigration, community development, care of the elderly, the effectiveness of the health system, and public safety and inclusion. Prague received a total of 29 points.

Tab. 3 shows the top 5 ranks in the IESE Cites in Motion Index ranking. After three consecutive years with New York at the top, London has taken back the first position, followed by New York and Amsterdam. The top 10 cities in the overall ranking are Paris, Reykjavik, Tokyo (6th), Singapore (7th), Copenhagen (8th), Berlin (9th), and Vienna (10th). The Czech Republic represented by Prague was 47th in the ranking. (IESE, 2019)

Table 3: City ranking – Compare Prague with the Top 5 Cities (Own calculation according to IESE, 2019)

Ranking	City	CIMI
1	London - United Kindgom	100
2	New York - USA	94,63
3	Amsterdam - Netherslands	86,7
4	Paris - France	86,23
5	Reykjavik - Iceland	85,35
47	Prague - Czech Republic	64,97

London is the first position in the overall ranking thanks to its very good performance in almost all of the dimensions. London is an example with its focus on communities in technology deployment. The British capital ranks in the 1st position in human capital and international outreach, 3rd in mobility and transportation, 7th for the governance dimension, 8th in technology and 9th in urban planning. However, the city does not show such a good

performance in the dimensions of social cohesion and the environment, which can also be seen from Fig. 3.

The overall comparison of Prague and London was carried out in the same indicators of the smart city concept. Fig. 3 shows that there is a consensus for the environmental indicator, otherwise London exceeds all other indicators, except social cohesion indicator.
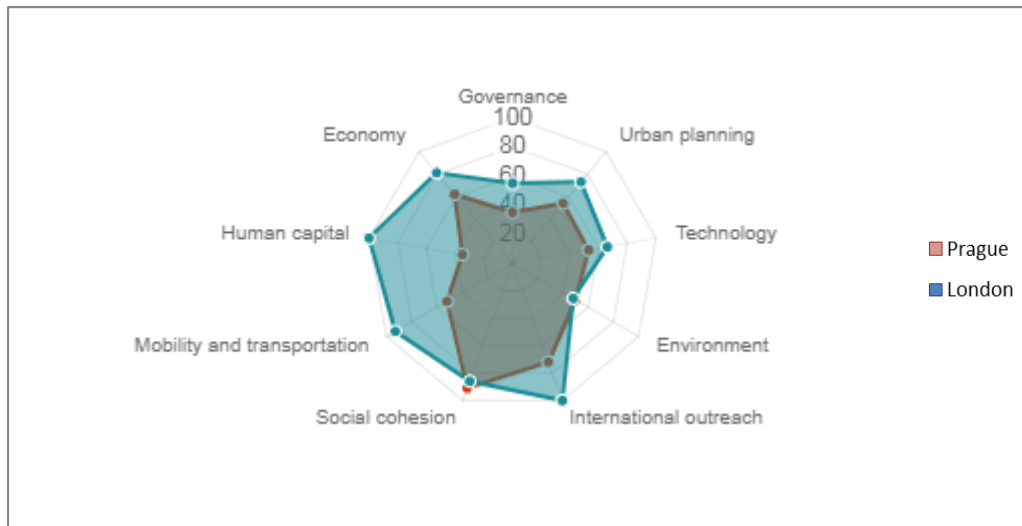

Figure 3: Comparison of Smart City concept indicators with Prague and London (Own calculation according to IESE, 2019)

Other research, by Philips Lighting and SmartCitiesWorld (2018), states that Singapore, London and Barcelona are among the top global smart cities. Research also shows that, according to 56% of respondents, the visionary leadership of the city is the most important factor influencing the success of individual Smart City programs. Research highlights the importance of enlightened leaders' influence with a long-term vision that involves collaboration between authorities and ministries. The benefits of the smart city principle are significant, according to a study that shows Barcelona as an exemplary example: around 47,000 jobs have been created through the implementation of the IoT, saving € 42.5 million for water and generating 36, EUR 5 million per year thanks to the intelligent parking system. All three selected cities are specific to their smart city program. Singapore, for example, is valued for its innovative approach to infrastructure, including buildings, transport and underground use. London is an example with its focus on communities in technology deployment. Barcelona is exceptional in supporting change at the highest government level.

4 CONSLUSION AND DISCUSSION

Technology will change the world. Smart City technology concept will serve cities as a means to work more efficiently, be environmentally friendly, and at the same time offer their residents the best place to live. (Green, 2019). There is no uniform guidance for all cities on how to do this. Each city is unique and faces its own problems, which it has to solve by combining different measures (He, Stojmenovic, Liu, & Gu, 2014). For the same reason, it is difficult to assess which city in the world is truly the smartest at present. There are a lot of charts that try to answer this question. One of the most complex is the Cities in Motion index, compiled by experts from the IESE Business School (IESE, 2019). So far, Europe has not reached a consistent methodology or measurable indicators for smart cities, even though such projects have already been supported. On the contrary, separate urban initiatives are emerging, which already have the first experience in implementing the concept, in order to share examples of good and bad practice (see The connected smart cities within the Eurocities

Association). Here, cities can draw inspiration and knowledge on individual smart programs and support technologies that will evolve and improve over time. Czech cities can also gain valuable knowledge and experience to set up their new internal processes in EU projects.

There are also some limitations in the implementation of the Smart City concept (Djunaedi & Widyawan, 2018). Budget constraints, lack of infrastructure and short-term planning are also often an obstacle to the Smart City concept. The most common obstacles are budget constraints (23%) and insufficient infrastructure (19%), which shows that securing investment in smart city projects is not an easy task. However, the results of the report suggest that projects that bring short-term profits and, in the long term, infrastructure improvements may overcome these problems, such as the San Jose street lighting project and the Los Angeles smart LED lighting, which bring annual cost savings of $ 9 million with guaranteed payback within 7 years. It is important to fully realize all the benefits of smart city. Cities use 70% of the world's energy and by 2050 urban areas will be home to 6.5 billion people worldwide, 2.5 billion more than today. In order for cities to continue to meet all existing requirements related to increasing occupancy and energy consumption, local authorities need to address potential problems related to technology, communication, data security and energy use. (Philips Lighting a SmartCitiesWorld, 2018)

The article publishes research results and shows current and planned technologies of the Smart City concept of selected cities in the Czech Republic. The first null hypothesis was rebutted and it was confirmed that even smaller cities below 150,000 inhabitants are using Smart City technology. Furthermore, the article shows a comparison of the capital of the Czech Republic with other evaluated countries. The research confirmed the second null hypothesis, where Prague ranked in the top 100 cities, namely 47th, which is a positive finding.

According to the author of the article, politicians do not have to come up with complex solutions. First and foremost, it is crucial to analyze the functioning of cities, to identify weaknesses and to develop comprehensive concepts tailored to individual regions. The first such concepts are already emerging (Czech Smart City Cluster, 2019). Thanks to them, Czech cities will become really smart. The Czech Smart City Cluster (CSCC) creates a unique partnership between companies, government, self-government, knowledge institutions and city dwellers. It seeks to build smart cities in which social and technological infrastructures and solutions facilitate and accelerate sustainable economic growth. These trends improve the quality of life in cities for all their inhabitants, making cities a pleasant environment for living and working. All this really works, but mere technology is not enough. People and their thinking will play a major role in building smart city. It is up to all of us now to get rid of the surviving stereotypes, to open ourselves to the possibilities that today offer us, and to make the world around us a little more "smart". We can conclude that the research results presented demonstrate useful implications for theory and practice, and highlight the need to implement Smart City technologies not only to improve the quality of life in cities. It will be interesting to continue to monitor the progression of Smart City technologies and conduct research that will reveal the strengths and weaknesses of Smart City concept for citizens and cities in general.

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