International Journal of Engineering & Technology, 7 (4.8) (2018) 592-595

International Journal of Engineering & Technology

Website:www.sciencepubco.com/index.php/IJET

Research paper

The Most Promising Innovation Solutions to Encourage a Conversion of the Existing Urban Areas into Smart Cities

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Abstract

The given paper is dedicated to the determination of the most promising innovation solutions to encourage a rapid conversion of the urban areas into the advanced Smart Cities. The main purpose of this research is to put everyone in the picture about the nature of the Smart City concept and to analyse the state of implementing the idea of Smart Cities in the European countries in order to define the most widely used smart solutions on this area. It is proved that Smart Cities are based on the competitiveness of cities and regions, social capital, governance and new public management, including the use of advanced technologies among these core elements. The research has been developed through a critical review of literature related to Smart City development all over the world. It is also revealed that Smart Cities exist on the close intersection of digital technology, disruptive innovation and urban environments. Consequently, a city can be defined as a "smart" one, when investments in human and social capital, infrastructure projects and disruptive technologies fuel sustainable economic growth and a high quality of life, with an effective management of the available natural resources, through participatory governance.

Keywords: *innovation solutions, Internet of Things, Smart City concept, urban expansion, urban management.*

1. Introduction

Urbanization is a global phenomenon that has totally changed and continues to alter not only landscapes and local environments, but also the ways in which human societies function and develop on the global stage. The positive relationship between urbanization and development was recognized by the world's governments only few years ago, when the "2030 Agenda for Sustainable Development" [1] was adopted at a special United Nations summit in New York. This document sets the 17 Sustainable Development Goals covering the main dimensions of social sphere sustainability, economics and environment.

Thus, in addition to other important goals, the world has received its first urban sustainable development goal: "to make cities and human settlements inclusive, safe, resilient and sustainable" [1]. Actually, this is an excellent confirmation of the fact that a good urban management is expected to play an important role in overcoming poverty and climate change mitigation in the world we live in.

According to the last official data provided by the United Nations Department of Economic and Social Affairs, "55 % of the world's population lives today in urban areas" [2] and "by 2050, two out of every three people are likely to be living in cities" [3]. In the given context it should be emphasized that throughout human history, cities have been the main centers of learning, culture, trade and innovation. Right now, cities are considered to be the places where new and valuable ideas crystallize, various innovations happen and creative solutions to different problems appear. However, in many cities, "unplanned or inadequately managed urban expansion has led to urban sprawl, pollution, environmental degradation, and, in some cases, heightened exposure to the risk of natural hazards" [4].

It is evident that the current state requires cities, local authorities and communities to find the better ways to meet the challenges of today and tomorrow. Consequently, further urban expansion everywhere should be accompanied by the rapid Smart Cities' development.

2. The smart way to develop Smart Cities

Cities from all over the globe, including small, regional communities and the existing global mega hubs, are currently working on the various smart city initiatives and strategies, in order to make their urban space more attractive to citizens and businesses investing in sustainable growth and development.

However, there are some serious obstacles to further implementation of these actions and transferring solutions and experience from one area to another is considered to be rather difficult.

Starting from ancient times, each city on our planet is really unique with its own character, grand history and traditions, cultural space and demographics. All these characteristics are expected to impact the way how smart and innovation solutions may emerge. Nevertheless, there are many substantial similarities between the cities, which seem to be worth investigating how best practices for financing, implementation and management can be shared and how the experience gained from earlier projects can be re-used again.

2.1. Understanding the essence of the term "Smart City"

The term "Smart City" originated during the crash of 2008, when the whole world was facing one of the worst economic downturn since the Great Depression. It was exactly at that time when "IBM", as a leading global information technology company, began to work on the "Smart City concept" in the framework of its "Smarter Planet Initiative". That was an absolutely new planet vision, based on three I's: instrumentation, interconnectedness and intelligence. "It showed a way for industries, infrastructures, processes, cities and entire societies to be more productive, efficient and responsive – particularly as many economies around the world were slowing and governments were looking for ways to rebuild their infrastructure" [5]. Therefore, by the beginning of 2009, the given concept has captivated the imagination of the various audiences around the world. Since that period of time, smart city strategies have been successfully implemented in different countries.
Nowadays there is no clear understanding of the essence of the Smart City (Table 1).

Table 1: Basic approaches to the definition of "Smart City" [developed by authors on the basis of the sources: 6; 7; 8; 9; 10; 11]

Basic approaches	Definitions	Source
General definitions	There is no absolute definition of a smart city, no end point, but rather a process, or series of steps, by which cities become more "liveable" and resilient and, hence, are able to respond quicker to new challenges. Thus, a Smart City should enable every citizen to engage with all the services on offer, public as well as private, in a way best suited to his or her hands. It brings together hard infrastructure, social capital including local skills and community institutions, and (digital) technologies to fuel sustainable economic development and provide an attractive environment for all.	The Department for Business, Innovation and Skills [6]
	Smart city is a term denoting the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.	British Standard Institution [7]
Data- and technology-driven definitions	A smarter city is one that uses technology to transform its core systems and optimize the return from largely finite resources. By using resources in a smarter way, it will also boost innovation, a key factor underpinning competitiveness and economic growth.	IBM Institute for Business Value [8]
	A Smart City uses digital technology to connect, protect and enhance the lives of citizens. Internet of Things sensors, video cameras, social media, and other inputs act as a nervous system, providing the city operator and citizens with constant feedback so they can make informed decisions.	Cisco Systems Inc. [9]
Citizen-focused definitions	It is a place where citizens have all the information they need to make informed choices about their lifestyle, work and travel options.	Polis – European Cities and Regions networking for innovative transport solutions [10]
	A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the need of present and future generations with respect to economic, social and environmental aspects.	International Telecommunication Union [11]

As can be seen from the Table 1, most of the above-mentioned definitions emphasize the function of the Smart City as a tool for connecting the various issues of a certain city. In addition, pooling of human and social capital with the available natural and economic resources determines the bases that a Smart City must integrate to generate more sustainable economic development and a better quality of life.
According to Vassallo J. [12], the following key areas should be identified in the development of any Smart City: the need for leadership and organizational change; the availability of a city plan; the existence of a robust legal framework; the presence of a technological model; the need for business models that ensure the effectiveness of the measures adopted.
Therefore, Smart Cities should not be seen as projects for the far future period. They are currently related to the wide range of public and private stakeholders, which actively use the most advanced technologies. In this context, it is about various "fixed and mobile high-speed broad-band connectivity networks, data collection through an extensive network of smart sensors, data analysis software, mobile applications, social media and web-portals" [13] and other equally important tools.

2.2. The Smart City concept in the XXI century

The Smart City concept is based on the viewpoint that technology is the main factor for the existing urban areas to follow the pace of transformation of society, as well as to meet the growing expectations and needs of the population. Moreover, this relatively new concept has proven to be essential in the process of making urban areas more efficient and sustainable.
In order to be considered smart, a city should cover significant aspects related to improved governance, urban planning, and infrastructure, as well as how this is reflected in human capital accumulation. Only in that case when these conceptual elements are taken together, the existing urban areas become effectively smart and capable for ensuring sustainable and integrated development.
During this study, it was revealed that the concept of smart city combines several core ideas of further urban development in a rapidly changing world.
The global Smart City market is enormous, and most cities around the world now implement Smart City initiatives and projects. "According to the criteria from the European Parliament's in-house think tank, almost all cities in Nordic countries of the EU are considered to be smart cities. Most cities with population over 100 000 people in Italy, Austria and the Netherlands are smart cities, as well as half of British, Spanish and French cities. In comparison, Germany and Poland are behind, while the eastern EU member states have the lowest number of smart cities" [14].
Following the scientific position of Sikora-Fernandez D. and Stawasz D. [15], "the European approach to smart cities development is based on actions aimed at reducing carbon dioxide emissions, as well as effective use of energy in all areas while improving the quality of its inhabitants' lives". Some national governments in Asia allocated part of their budgets for smart city projects to increase the global competitiveness of the cities. Thus, for example, "China has set aside $16 bn to develop 193 localities and economic development zones, while India pledged to invest $15bn for its 100 smart cities ambition by 2022, and Singapore's latest five-year plan includes more than $13 bn investment in technology solutions for its "smart nation" objective" [16].
Despite this, there is no "one size fits all" model for smart cities that can be replicated everywhere. That is why there is a critical need for defining the main pillars of a Smart City development.

2.3. The main pillars of a Smart City development

The Smart City is considered to be an umbrella concept, which requires a combination of smart efforts not only to improve the quality of life for the residents, but also to promote sustainable economic growth (Fig. 1).

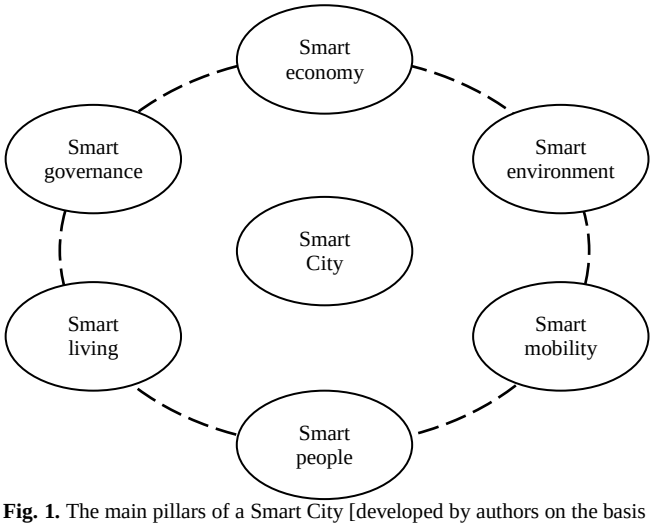

Fig. 1. The main pillars of a Smart City [developed by authors on the basis of the sources: 15; 17; 18; 19]

Fig. 1 illustrates a clear and a systematic overview of the main pillars of a Smart City, the essence of which we propose to consider below. One of the most popular and highest priorities of Smart City pillars is the smart economy. It can be described as an economy in which all efforts are focused on the stimulation of innovation [17].

Another pillar is the smart mobility, which finds its manifestation in the use of information and communication technologies, necessary to support the efficient operation of the existing transport and logistical systems in order to make mobility as smart as possible. Obviously, all levels of transport network should be coordinated and integrated to create a "unified virtual transport platform, which would include cars, trains, airplanes and even bicycles and pedestrians as well" [18]. As Boelens L., Lauwers D., Witlox F. [19] emphasize, adopting smart mobility would facilitate clean transport, avoiding traffic problems, providing better parking opportunities and so on.

The next pillar worth enough to be mentioned is related to smart people. This means that any Smart City is a city, which has a direct relationship with valuable social and human capital. Consequently, all changes in the city environment should be initiated by its citizens only. As a result, "citizens should be able to acquire e-skills, working in ICT-enabled jobs, having access to education and training, human resources and capacity management" [19], within an inclusive society that fosters innovation, entrepreneurship and the efficient use of the natural resources.

Smart environment is another pillar we need to consider during the study. In this regard, authors, such as Sikora-Fernandez D. and Stawasz D [15], focus our attention on the fact that any smart city is interested in optimization of the energy consumption by using renewable energy sources. Therefore, the city bases its own management policies on the principles of sustainable development.

The next pillar is nothing like smart living, which is the opportunity to use smart technologies to make lifestyles of the citizens more comfortable. In addition, with open data and opportunities concerning big data, some "citizens may develop their own ideas of how to make life easier, which result in crowd sourcing of smart applications all over city life" [18].

The last, but no less important pillar is smart governance, which requires careful political and sensitive government that would be able to work on the following levels: within the city for its inhabitants, coordinate and govern upward in balance with the central government and keep bridges open with local governments of other urban areas within the region or a country [15; 18].

On the basis of the above considerations, it's reasonable to assume that a city is smart when investments in human and social capital, traditional transport system and modern digital infrastructure stimulate the rapid economic growth and a high quality of life, with a thoughtful management of natural resources through participatory governance.

3. Continuous innovation is in the core of the Smart City development idea

Creating successful Smart City initiatives requires collaboration between individuals involved, local city governments and a fast-growing range of private commercial organizations. Most governments are unable to fund these initiatives from taxpayer's income only. This circumstance compels them to seek profitable partnerships and alliances with various commercial structures.

This is the place where problems start to appear. In the present-day context, the leading commercial entities are interested in partnering with city governments for several reasons. They want to test their innovations and to get an access useful development data and other favorable conditions for building their own businesses. As practice shows, commercial structures do not have the same agendas as the cities, themselves, so the expected partnership outcomes may not be precisely what the local city government is interested in.

Various rankings describing a wide range of Smart City characteristics can become helpful tools to determine the specific assets of a certain city in a benchmarking process. One of the most authoritative rankings was published by Stockholm-based smart parking service "Easypark" in 2017. The company managed to create the index by studying over 500 cities from the developed and the developing economies. Several groups of factors, related to smart city technology, were measured and graded on a 1-to-10 scale. According to this index, the top smart city was Copenhagen, while the other top five also included Singapore, Stockholm, Zurich and Boston (Fig. 2).

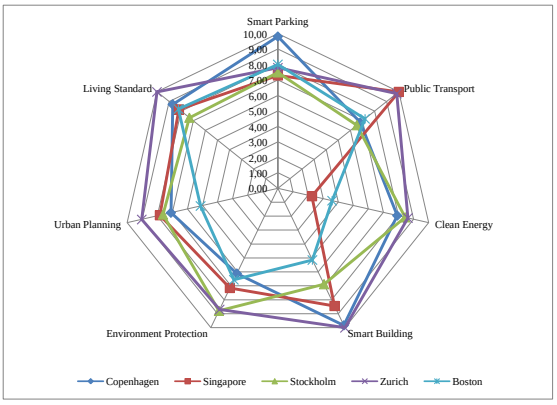

Fig. 2. Top-5 of Smart Cities, 2017 [completed by authors on the basis of the source: 20]

In the authors' opinion, such a ranking can be considered as a tool for city government representatives, heads of the leading information technology companies and other interested groups that want to improve the quality of life of the city's inhabitants. Moreover, studying the most advanced cities in each category of factors provides a source of inspiration to reveal the best practices for more innovation solutions and sustainability.

Through this research we have come to certain conclusions.

Nowadays many smart city initiatives exist, and this momentum found its expression in the following emerging trends. The first one is related to the fact that the leading cities have laid a solid foundation for the progressive development of innovation and technology. The main task now is to integrate the formed innovation culture with the day-to-day operations of the existing urban space. The second emerging trend points to the emergence of so-called "City platforms". It is about the fact cities are actively implementing the strategies to deployment of 5G and other technologies. The third trend is the one that is related to a holistic vision of the city challenges.

In general, the process of transforming of the existing urban area into a Smart City is rather complex and multidimensional in nature. Indeed, such a transformation affects many aspects of city operations, including the above-mentioned pillars of a Smart City.

Two main conditions can be identified in such a process. First of

all, this transformation can take place in one or more sectors of the existing urban area only. Secondly, it is that how much technology and smart applications are incorporated. So a transformation is the change that embeds technology in the city life (Table 2).

Table 2: Fundamental changes in the process of Smart City transformation [developed by authors]

Types of change	Main issues	Short-term period	Medium-term period	Long-term period
Technological changes	Emerging technologies	Open data apps to improve the urban experience	Multimodal sensor system. Location aware apps and services	Urban "Internet of Things" platforms. Cloud based ontology.
Industrial changes	Networks of technology developers, providers and appliers	Sensors into utilities and energy networks	Partnerships between large companies and the leading cities	Large-scale applications mix
Social changes	Values, preferences, needs of the end-users	Experimental facilities	Multiple city pilots	Large-scale demand for city infrastructure

As can be seen from the Table 2, all the above-mentioned changes can take place over three different periods of time. Short-term period changes are always well controlled and require quick actions. On the contrary, medium-term period changes are usually defined in those stages, where the previous actions "contribute to and / or result in other longer term actions" [18]. And, finally, long-term period changes in the process of Smart City transformation can be defined as those changes, which require not only careful planning, but also the efficient management and control.

4. Conclusions

The findings of the research revealed that Smart City is an innovative city that uses Information and Communication Technologies and other means to improve quality of life of its citizens, as well as to increase the efficiency of urban operation and services, while ensuring that it meets the needs of present and future generations.
Today many cities all over the world are finding their way to become smart cities, because these highly advanced urban areas are able: to optimize the allocation of the available resources and ensure the reduction of the unnecessary spending; to provide better customer service to users; to improve the established image of public agencies thereby raising the level of satisfaction of the city's inhabitants; to achieve the greater involvement of citizens in the administration processes through the use of various innovation solutions that help monitor and evaluate public services by informing and interacting with the local government in order to address concrete problems and challenges in society.
The most promising smart city innovation initiatives connect local governments, business structures and citizens with each other and improve services and information. These efforts perfectly demonstrate the aspiration of smart cities and public-private partnerships to improve the quality of life for all society members. The most important sectors of the urban life such as health and public services, education, trade and business processes can be easily transformed into really smart sectors through the comprehensive support of the e-services.

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