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THE TIMES THEY ARE A-CHANGIN'

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SUCCESS FACTORS OF SMART CITIES

A SYSTEMATIC REVIEW OF LITERATURE FROM 2000-2018

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ABSTRACT

The aim of this paper is to review smart city literature to achieve these goals. More than 150 sources of literature were approached and analyzed with a view of finding out drivers and success indicators of smart cities on which future research policies are depend. The results pointed out several drivers that stimulate cities to be smart. These drivers are related to economy, environment, governance, safety, energy, living, technology, buildings, education and people. Interestingly, a smart city should be distinguished by smartness extent achieved to meet the requirements of these drivers. That is, a smart city is the one that marked by its own smart economy, smart environment, smart governance, smart safety, smart energy, smart living, smart technology, smart buildings, smart education and smart people. This paper contributes to smart city literature by showing drivers and indicators related to smart cities success.

KEYWORDS:

Smart City; Drivers of Smart City, Indicators

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智慧城市的成功因素：系统性文献综述（2000-2018）

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摘要

本文旨在通过梳理智慧城市文献资料，实现所述目标。通过对150多篇文献资料进行查阅和分析，发现智慧城市各大驱动因素和成功指标，供未来研究政策所参考。研究结果指出了促使智慧城市形成的几大因素。这些驱动因素涉及经济、环境、治理、安全、能源、生活、科技、建筑、教育和人员。有趣的是，一座智慧城市的划分，应取决于该城市达到的智慧程度是否满足这些驱动力的要求。也就是说，智慧城市是以自身的智慧经济、智慧环境、智慧治理、智慧安全、智慧能源、智慧生活、智慧科技、智慧建筑、智慧教育、智慧人员为特征的城市。本文通过阐述与成功的智慧城市相关的各大驱动因素和指标，为智慧城市的研究文献做出了贡献。

关键词：

智慧城市；智慧城市的驱动因素；智慧城市的成功指标

1 INTRODUCTION

In recent years the smart city concept becomes a general term used to refer to a positive process of urban areas (economic, environmental, transport, social, etc.) (Papa et al., 2015). Smart city concept has gained great attention in the literature since the concept was deemed as a crucial aspect of future urban planning (Albino et al., 2015). Babar (2016) estimated that 80 percent of citizens all over the world by 2020 will live in cities. Monteiro et al. (2018) pointed out that the real reason behind the emergence of this term was to find appropriate solutions in response to population growth in the cities. Numerous terms related to the smart city concept were found in the literature. Examples of these terms include: intelligent city, innovative city, flexible city, attractive city, and resilient city, digital city, high-tech city, green city, and low carbon city (Albino et al., 2015; Caragliu et al., 2011; El-Messeidy, 2016; Makhoul, 2015; Tahir and Malek, 2016).

The concept of the future city at the urban scale, focuses on the improvement the relationship between technological advancement and sustainability challenges (Moraci & Fazia, 2013). In general, definitions of smart city concept followed two major lines; a narrow line and a wider line. The narrow line in defining smart city describes this concept in terms of information and communication technology used in cities in order to manage activities, events, resources and to cope with city development consequences.

In this line information and communication technology was used to provide solutions to problems facing cities (De Oliveira et al., 2018). The widest line of the concept encompasses several aspects that go beyond information and communication technology such as social, economic and environmental aspects (Lacinák & Ristvej, 2017; Makhoul, 2015; Tahir & Malek, 2016). In a study by Albino et al. (2015), more than twenty-five definitions of smart city were cited. These definitions can be categorized into two groups related to information and communication technology and a mix of technology and investment in physical, human and social capital using governance and economic development framework. Beretta (2018) conceptualized smart city as an integration of information and communication technology with human and social capital. In the same context, Caragliu et al. (2011) divided the concept of smart city on the basis of its infrastructure into two types which were physical infrastructure along with the human and social infrastructure. In this paper, the wider line of smart city definition was followed to gain more understanding of this concept and factors that play critical roles in its achievement as an intended goal of many cities across many countries. Adopting the wider perspective of smart city, the term was defined as a system of inter-correlated subsystems, including energy, mobility, flows of materials and services, and people (El-Messeidy, 2016).

The introduction of the smart city concept was derived by numerous factors. Many countries are striving to have its own smart cities due to numerous challenges such as dealing with the increased growth of their population, increased pollution of air and contributing to the global to reduce the warming dilemma (El-Ghorab & Shalaby, 2016; Lacinák & Ristvej, 2017). In order to eliminate or at least reduce these problems, a deep review of smart city literature is required to determine aspects that should be kept in mind when smart city planning process starts. These aspects represent indicators of smart cities and can be considered as outcomes for smart cities development. These indicators enable cities to achieve criteria stipulated to describe a city as a smart city (Al Nuaimi et al., 2015). That is, indicators of smart city refer to success factors of developing smart cities. They highlighted some examples of these indicators such as intelligent management of city resources and facilities, mobility, environment, governance, and people. Meijer and Bolívar (2016) indicated that a smart city can be described in terms of three major components: smart technology, smart people, and smart governance. Tahir and Malek (2016) studied the requirements of achieving smart city goals and concluded that smart environment and smart mobility were the most important indicators of the successful development of smart city, followed by other indicators such as smart living, smart economy, smart governance and smart citizen.

Tok et al. (2014) cited the following smart cities indicators: smart living, smart mobility, smart environment, smart economy, smart people, and smart governance. All in all, indicators of smart cities when achieved are

regarded as signs of successful construction of smart cities. Al Nuaimi et al. (2015) reported several definitions of smart city from which different aspects of smart city can be concluded.

Indicators of smart city extracted from these definitions include physical infrastructure, social factors, human factors, the Internet of things, monitoring of resources and life activities in a country such as roads, ports, communications, natural resources, transportation, socio-economic development, improved governance and innovative management of resources.

Joshi et al. (2018) identified six indicators of smart cities: smart living, smart governance, smart people, smart economy, smart mobility and smart environment. Numerous literatures carried out on smart city revealed the same indicators (Cocchia, 2014; Arroub et al., 2016).

Based on these studies, the main focus of this paper is on indicators that distinguish smart cities. In fact, these indicators can be used to guide the overall process of smart city adoption since it provides policy makers, urban planners and designers with criteria that should be noted in the construction of smart cities. On the other hand, this paper enriches the body of smart city literature by elaborating significant lessons learned from global experiences in the same domain.

In other words, indicators of smart cities can be analyzed to draw a conclusion about the success factors of smart cities. (Minimum length of your contribution is approximately 40.000 characters including spaces).

2. RESEARCH METHODOLOGY

2.1 RESEARCH STRATEGY

Khan et al. (2003) identified five steps of conducting systematic reviews; formulation of research questions, searching relevant sources of papers and identifying inclusion and exclusion criteria, assessment of study quality design, summarizing the evidence and interpreting the results. Uman (2011) reported the following phases of systematic review; formulation of research questions, definition of inclusion and exclusion criteria, developing research strategies and locating articles, a selection of articles, extraction of data from these articles, assessment of study quality, analysis of studies and interpretation of findings.

Cocchia (2014) conducted a systematic review of smart city literature from 1993-2002 by collecting, storing and organizing a set of papers on the smart city concept on the basis of time, terminology, definition, typology and geographic analysis. Research strategy used in this paper consisted of formulation of research questions, the criteria used for inclusion, selection of articles, analysis of articles, and interpretation of findings.

2.2 RESEARCH QUESTION

The challenges faced by the developing countries are still full of the many problems facing sustainable development, which need integrated solutions for these problems in different sectors, by a focus on communications and information sector that have become the characteristic of urbanization.

For most of the cities of the world, information technology has become an important factor in the change and development of cities. The global network (Internet) has changed the urban planning model by convincing traditional planners to look at the urban planning of the city.

The technology to make the economy, the environment, mobility and governance more efficient and efficient. The concept of "growing cities" on the implementation of the correct urban planning can transform the city into a Smart city. This paper seeks to answer the following question: what are indicators of a smart city? In fact, answering this question guided the research towards a new direction.

That is, the determination of smart city indicators helps to propose a theoretical model on which future studies can depend in order to evaluate the effectiveness of smart cities and to determine the outcomes of these cities.

2.3 CRITERIA OF ARTICLES INCLUSION

Relevance of articles in terms of content, publication date, and type of the journal. Content of selected articles should be related to the research question. Articles were included in the systematic review after reading. Publication date of articles should be from 2000 to 2018.

So, the article published before 2000 was excluded from the review. On the other hand, all articles used in this paper can be cited using journal name, volume or issue number. Some articles were selected from proceedings related to the same context.

2.4 STUDIES SELECTED

The initial round of articles collected through searching databases resulted in 171 articles. Numerous keywords were used when searching for articles such as smart city, urban sprawl, transportation, Urbanism, governance. Out of these articles, 74 articles were excluded on the basis of their contents.

Due to the type of the journal and publication date limitations, 13 articles were also excluded. Hence, the final number of articles included in this review were 84 articles.

3. FINDINGS

Tab. 1 shows smart city indicators found in the literature. Examples of these indicators can be categorized under 12 characteristics: smart living, smart economy, smart environment, smart education, smart governance, smart energy, smart safety, smart mobility, smart technology, and smart buildings. These pillars were designated as dimensions, components, indicators and factors of smart cities.

| No. | Smart city success characteristics | Related features | Researchers |
|-----|------------------------------------|--|---|
| 1 | Smart living | Life recreations like stadiums, theaters, public libraries; Healthy housings; e-life styles; cultural facilities and diversity | Chorianopoulos et al. (2010); Giffinger & Gudrun (2010); Occelli & Sciallo, (2013); |
| 2 | Smart economy | ICT infrastructure; labor market flexibility; ICT-based production process; productivity; use of e-business applications; economic image; high tech industries | Angelidou (2017); Caragliu et al. (2011); Lombardi et al. (2011); |
| 3 | Smart environment | Low level of carbon dioxide emission; open green spaces; water efficient use and water quality; effective management of waste and recycling; pollution control; sustainable development of urban areas; recycling projects | Nam & Pardo (2011); Lombardi et al. (2012); Lazaroiu et al. (2012); Balakrishna (2012); Pan et al. (2013); Jayashree et al. (2014); Tok et al. (2014); Abdou (2014); Buckman et al. (2014); |
| 4 | Smart education | Education facilities, percent of funding research by private sector; remote access to education programs; | Albino et al. (2015); Li et al. (2015); Al Nuaimi et al. (2015); Amditis & Lytrivis (2015); Meijer |
| 5 | Smart governance | E-government services; research and development centers in the city; smart administration; participation in decision-making process; transparency. | |

| | | | |
|----|------------------|--|--|
| 6 | Smart energy | Renewable energy projects; efficiency of energy systems; percentage of electricity generation; total consumption of energy | and Bolivar (2016); Sharma & Gupta (2016); Tahir & Malek (2016); |
| 7 | Smart safety | Individual safety, city sensor tracking; alerting systems; emergency response systems. | Olaverri-Monreal (2016); El-Messeidy (2016); |
| 8 | Smart mobility | ICT-based transportation; ICT-driven logistics; advanced driver assistance systems; smart maintenance; safe transportation; sustainable transport system, e-monitoring of transportation system. | Lacinák & Ristvej (2017); Abo-elazm & Ali (2017); King & Perry (2017) ; De Oliveira et al. (2018); Venkatesan (2018); |
| 9 | Smart technology | Internet infrastructure; Intern accessibility at homes; high-tech training; and software engineering. | Beretta (2018); Kaur et al. (2018); Hargreaves et al. (2018); Klassen & |
| 10 | Smart buildings | Housing quality, using solid waste management, reduced cost of construction; smart heating, smart air conditioning, smart monitoring; smart lighting; smart plug load; and smart window shading. | Buske (2018); Wu et al. (2018); Adapa (2018); Joshi et al. (2018), Thaduri et al. (2018); Al-Alwani (2018); Ibrahim et al. (2018). |
| 11 | Smart hospitals | Health conditions; health care services; e-monitoring of patients at home; connections between hospitals; biomedical sensors and hospital smart architecture. | |
| 12 | Smart people | Innovative solutions to city problems; participation in sustainable development; participation in public life; access to e-training and e-learning courses; skilled workforce; employment rate in knowledge sectors. | |

Tab. 1 Success indicators of smart city found in the literature

4. DISCUSSION AND CONCLUSION

The main idea behind the construction of smart cities is to make cities more adaptable to challenges in different contexts. According to Abo-elazm and Ali (2017), evaluating the development of smart cities can be achieved in terms of the assessment of benefits such as functional, structural, formational, technological, economic, social and environmental benefits. Guiding smart city construction using the idea that built on the integration of numerous smart aspects to be effectively employed by technology solutions was in agreement with many conceptualizations of this term as provided by many authors (Abo-elazm & Ali, 2017; Albino et al., 2015; Al Nuaimi et al., 2015; El-Messeidy, 2016; Lacinák & Ristvej, 2017; Lombardi et al., 2011; Sharma & Gupta, 2016; Tahir & Malek, 2016; Wu et al., 2018). The results of the literature conducted in this paper pointed out that smart cities are built on several pillars: smart living, smart economy, smart environment, smart education, smart governance, smart energy, smart safety, smart mobility, smart technology, smart hospitals, smart buildings, and smart people. The following sections provide a detailed explanation of each of these dimensions. Smart living refers to life recreations like stadiums, theaters, public libraries, and entertainment venues (Albino et al., 2015). Wu et al. (2018) defined smart city as a city digitally designed using advanced applications of information and communication technology like Big Data, the Internet of Things (IoT) and cloud computing. For the National development and Reform Commission of China, the concept of smart city was described as a

new model or idea adopted to plan, construct, and manage service based on cloud computing, Big Data, and IoT (Li et al., 2015). Simply defining the concept, Tok et al. (2014) and Ibrahim et al. (2018) described smart city in terms of quality of life. Smart economy, according to Albino et al. (2015), represents a key theme of smart economy, which was the availability of information and communication technologies and the ability to use technologies in production.

For Ibrahim et al. (2018), smart economy represents the concept of competitiveness. Lombardi et al. (2011) specified five smart cities indicators: smart living, smart people, smart economy and smart environment. Concerning the smart environment, Lombardi et al. (2012) portrayed this dimension of smart city in terms of level of Carbon dioxide emission, green spaces, efficient water use, effective management of waste and recycling. Smart education, on the other hand, refers to using electronic learning applications that enhance the learning process, computerized schools and ensuring students access to educational resources (Sharma & Gupta, 2016). Al Nuaimi et al. (2015) indicated that smart education can be achieved through the use of information and communication technology that enhance citizen involvement in learning environment and knowledge management practices and building knowledge-based community. Moreover, Lombardi et al. (2012) represented smart governance in terms of the number of universities in the city and research centers, e-government services, Internet access by homes, and the number of e-government users.

In relation to smart energy, El Messeidy (2016) defined smart energy-oriented smart city as a city uses renewable and efficient energy and provide its occupants with access to energy. Therefore, the focus of smart energy is to reduce energy use and greenhouse gas as well as to encourage innovation in this context (Stoltz et al., 2015). Smart safety, according to Van Heek et al. (2016), exemplifies a critical component of smart cities due to its role in ensuring an effective participation of people in social as well as economic life. Examples of smart safety application include tracking misbehavior of people, monitoring social activities, and detecting specific people in case of disasters and criminals (Pan et al., 2013).

Albino et al. (2015) indicated that the aim of smart mobility is to enhance transportation the city through the employment of advanced technology in transportation process. For Pan et al. (2013), smart mobility or transportation is one of the most important applications of smart city by which cities can manage traffic conditions, supply and demand of transportation, route navigation and reporting traffic state. Examples of smart mobility can be found in Germany, USA, France and Singapore (Joshi et al., 2018). Smart technology in its general definition covers other factors of smart city such as smart living, smart energy, smart transportation (Meijer & Bolivar , 2016). For the current study, the concept was analyzed as a separated factor in order to describe the availability of the infrastructure of the Internet in the city in addition to Internet access as well as technology innovations. King and Perry (2017) identified several technologies that can be used to enhance operations of smart buildings.

These technologies are related to smart heating, smart air conditioning, smart monitoring, smart lighting, smart plug load, and smart window shading. Examples of smart hospital systems include electronic monitoring of patients that provide two major activities: continuous follow-up of patients and transfer of e-data (Jayashree et al., 2014). Finally, the concept of smart people describes citizens who have innovative solutions to city problems, participate in the sustainable development as well as the public life, skilled and have an access to e-training and e-learning programs (Giffinger & Gudrun, 2010, Hernández-Muñoz et al., 2011; Nam & Pardo, 2011).

A final note in this paper indicated that adopting the concept of smart city, planning to construct this city and putting it into practice considered a beneficial step in the right direction since these cities help countries to cope with different challenges either at global, regional or local levels. Successful indicators required to construct smart cities depend not only on smart technologies used in these cities, but also on another set of indicators comprise smart economy, smart governance, smart environment, smart mobility, smart living, smart safety systems and smart people.

The most critical point revealed in the literature is that all indicators of the successful development of smart cities should be integrated as a one system which utilize smart technologies to achieve this goal. The ultimate end of these integrated indicators is a smart city characterized by advantageous services provided to occupants.

5. PLANNING IMPLICATIONS AND FUTURE RESEARCH AGENDA

The results pointed out, based the review of the literature conducted in this paper help policy makers, urban planners and designers by underling benefits and success factors that should consider in order to translate theoretical concepts of smart city into real projects. Lacinák and Ristvej (2017) indicated that smart cities enable countries to solve numerous problems such as air pollution, population growth and ecosystem problems such as global warming. In an effort to cope with these challenges, smart city concept was introduced as an overall system link different aspects of city life, including environment, energy, people, transportation, governance and so on. In order to ensure an effective construction of smart city, the ultimate result of a smart city project should produce a city with distinguished indicators. Many drivers that lead countries to create their smart cities were found in the literature.

The main source of these drivers are challenges facing cities. El-Ghorab and Shalaby (2016) indicated that challenges and their related reasons are the main sources that results in countries adoption of smart city solutions. According to Klassen and Buske (2018), planning and designing smart cities requires an integration of three main aspects: needs of residents, quality of life standards and availability of services. However, readiness for change as stated by Ibrahim et al. (2018) should be considered in smart city planning. Lazaroiu and Roscia (2012) reported two main conditions for a city prior, to be smart city: it should be a medium city with a full coverage of accessible databases. Reed et al. (2018) highlighted the importance of relationships between natural and artificial environment. Reviewing conclusions of previous studies conducted on smart cities in different regions revealed many suggestions.

For instant, providing a broaden research to cover many smart cities (Beretta, 2018) in relation to many aspects such as sound analysis to detect noise pollution (Bello et al., 2018), smart water solutions (Dickey, 2018), using computational intelligence to enhance education (Gomede et al., 2018), smart streets (Ahmed & Rani, 2018), smart water grid (Kim, 2018), and smart parking (Tomar et al., 2018). Future research on smart cities construction could be conducted to investigate the impact of mart cities on functioning of cities in terms of benefits acquired as a result from the development of smart cities. Since buildings are the main aspect of cities, the overall concept of smart city should consider how these buildings could be transformed into smart ones. Therefore, case studies of smart buildings across the world should be reviewed in order to justify their constructions and adopt criteria that fit the local environment and resources well.

Finally, it was concluded that smart cities should meet several criteria to deserve this name, these criteria include basic consideration that these cities should show such as adaptability to environmental problems, ability to meet citizen's needs, construction on the basis of people skills, and utilization of innovative solutions with adopting new technologies. Additionally, further studies in the same context are required, such as factors that hinder the adoption of the smart city concept, Recent studies highlighted the importance of new trends in smart cities context like using cloud computing to provide and support new services (Hosseinian-Far et al., 2018).

This paper contributes to guide future study, especially in developing countries towards guiding sustainable development programs to build smart cities by focusing on smart cities pointers, mind full, highly tactile smart cities and the critical success factors that will enable developing countries to achieve progress and development in the future, and access to the quality of life.

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IMAGE SOURCE

Fig. Cover: Jul 24, 2017 by Gary Shapiro, Three Reasons Why You Should Invest In Smart Cities Now. Consumer Technology Association President and CEO.

Rest of table by the author.

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