

**COPENHAGEN AS A SMART CITY***Crina Veronica CRISTEA<sup>1</sup>**Daniel ALEXANDRU<sup>2</sup>**Darko SULESKI<sup>3</sup>**Alexandru BIRSAN<sup>4</sup>*

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**ABSTRACT**

*When talking about smart cities, one must mention Copenhagen which was nominated several times as one of the Smartest Cities. Nonetheless, we must take into consideration that, in general, these rankings have various and limited standards since they either evaluate certain areas of a Smart City or they compare Copenhagen to different other cities. The present paper will focus on Copenhagen in an all-round undertaking. Therefore, the article will try to find answers to two important questions: "Is Copenhagen a Smart City?" and "What makes Copenhagen smart?". By evaluating Copenhagen, this paper follows its trail on development and at the same time offer a suitable Smart City model that can be used as a template in smart developing of cities around the world, including Bucharest. Having current literature as a starting point, scholars developed a new interesting Smart City model. This model helps differentiate short-term and long-term Smart City success factors. The two distinct perspectives are explained in detail making them suitable for any Smart City. Based on this model researchers examine the long-term success factors of the Smart City Copenhagen. A quantitative analysis is considered as relevant for the subject in discussion. Therefore, several factors combine and reveal key success factors in Copenhagen, for instance the collaboration between the municipality and the citizens and the mentality of the society. In order to further develop as a Smart City, Copenhagen needs to focus on cooperation within and across municipalities and also strengthen public-private partnerships.*

**KEYWORDS:** *smart city, smart governance, smart economy.*

**JEL CLASSIFICATION:** *R1, R5.*

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**1. INTRODUCTION**

In their study, McKinsey & Company reached an interesting conclusion that for the first time in history, in 2010, more people lived in cities than in rural areas generating more than 80% of the world's GDP (McKinsey & Company, 2011). On the negative side, approximately 70% of CO<sub>2</sub>-emissions accumulate in cities (Mortensen, Johnsbank Rohde, Rovsing Kristiansen, Kanstrup-Clausen & Lubanski, 2013). Taking into consideration that until 2050 cities population is expected to grow from 4 billion to 6 billion, CO<sub>2</sub>-emissions will continue to grow alarmingly (United Nations, 2012). In addition, if we evaluate in terms of the amount of money lost, the traffic congestion in the USA costs US\$78 Billion for a total of 4.2 billion lost hours (Peirce, Johnson, Peters, & Foundation, 2008). Additionally, preference towards cities continues to rise and this will

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<sup>1</sup> Bucharest University of Economics, Romania, crina.cristea@gmail.com

<sup>2</sup> Bucharest University of Economics, Romania, dan74a@yahoo.com

<sup>3</sup> Bucharest University of Economics, Romania, darko\_suleski@yahoo.com

<sup>4</sup> Bucharest University of Economics, Romania, alex\_brsn2007@yahoo.com

lead to more traffic congestion (Dirks & Keeling, 2009). All these examples highlight that urbanization continues to develop posing even more difficulties.

A study on Smart Cities can start by investigating the components and functions of a city. Having in mind the variety of perspective, we can identify numerous city definitions. Some researchers focus in their definitions on the density of population and the geographical size, highlighting the differences between rural and urban areas. On the other hand, other scholars focus on the degree of interaction within a determined region (Paddison, 2001). Moreover, Baleswar Thakur puts together these two perspectives and defines a city as a "People-Space-Function" existing over a period of time (Thakur, 2007, p. 3). Despite the wide variety of city definitions, this paper will focus on the perspective most relevant for the research. Therefore, for this study it is less suitable a geographical or demographic definition, because these features vary heavily between cities from different countries and hence they become less relevant. The purpose for the development of a city is more relevant and, in this context, the definition of R. Davis as "concentration of many people located close together for residential and productive purposes" (Davis, 1973, p. 23) presents a variety of hard factors (for instance density of population, number of residents) but, more important, highlights the main purpose of a city: to offer residence and enhance productivity. To fulfil its purpose the city utilises resources and produce outputs. As mentioned above, in the context of increased urbanization cities are struggling to efficiently fulfil their purpose.

The development of cities offers the answer for this, since the first settlements had the home as the centre of living. The family was the one providing work, education and healthcare. Nonetheless, industrialization has led to the centralization of several functions in order to increase productivity: schools became providers of education, production took place in factories and healthcare was provided in hospitals. This also helped the mobility of city residents; later were built streets to increase mobility in these cities, enabling population to commute to work by car. Until now, no significant changes were made to this model the majority of cities today still rely on the city's operating principle of industrialization (Buscher et al., 2010; Larson, 2012). The issue of mobility makes obvious the need for cities to reconsider their present strategy of managing life and create and develop more efficient and intelligent solutions. Smart Cities is the answer to this problem aiming to overcome the challenges coming along with increasing urbanization in order to maintain a high quality of life within cities. Undisputedly, increased urbanization has its advantages in helping to counteract the difficulties and increase the quality of life of the citizens: for instance, the high density of population and the implementation of ICT solutions allow citizens to reduce their commuting distances, improve pollution and time loss (Teller, 2011). Additionally, cities bring together a large number of high-skilled workers, whose knowledge can be more easily used to create new and better solutions (Mortensen et al., 2013).

Therefore, despite the advantages, increased urbanization also brings forward serious challenges and in order to overcome those, cities must rethink their management strategies and create better solutions and the way to do this is by becoming Smart Cities. Having as a starting point the need for a larger number of Smart Cities and also the success of Copenhagen, the present study investigates in detail Copenhagen as a Smart City. Moreover, by evaluating Copenhagen, this paper aims at putting forward a complex and coherent definition of a Smart City, given the variety of definitions of this notion, each one focusing on a different aspect. The research will centre around two key questions - Is Copenhagen a Smart City? and Why is or isn't Copenhagen a Smart City? The first question is important especially because of its simplicity, offering a straight answer, if Copenhagen is or isn't a Smart City. Taking into consideration the different approaches of researchers on Smart Cities, the simple answer it requires is the main advantage of this first question. The second question's objective is to identify and evaluate the strong points and the weaknesses of Copenhagen. This question also helps to identify the areas which require more attention from the administration in Copenhagen and, moreover it provides answers and examples for other cities that have Copenhagen as a model of a Smart City. A new term emerged, "Copenhagenize"

(Copenhagenize Design Co., 2013), describing the process of identifying common characteristics by other cities and applying them to their own problems.

In respect to methodology and the structure of this study, the paper has four parts proportioned in manner that better suits the topic of interest. The introduction briefly presents the relevance of this research and asks the research questions. The second part elaborates a model of a Smart City having as a starting point the research questions. This model is developed starting from a detailed literature review and a thorough research on the topic. The Smart City framework offers a rather precise description of the various features of the Smart Cities, this approach being useful in helping the reader to better understand the Smart City. Also, it completes the knowledge on the subject by introducing a new perspective on the Smart City. Returning to the research questions, they highlight the importance of distinguishing between short and long-term perspectives on the Smart City. Moreover, by decomposing the Smart City into distinct components, indicators and measures, the model mentioned above creates a foundation to help answer the research questions of this study. Taking into consideration that the afore mentioned framework was developed starting from the current literature review on Smart Cities, university research and paper from a business perspective, it indisputable proves that the analysis on Copenhagen concentrates on meaningful aspects and, therefore, the end results will be relevant for academic and business purposes. The third part of the paper is dedicated to the presentation and examination of the relevant data for the Copenhagen model so that at the end of the chapter to analyse the results. In examining the data and answer the research questions will be employed the quantitative method. The forth section is in fact a critic analysis of the information gathered, at the same time answering to the research questions.

## 2. LITERATURE REVIEW

In relation to a Smart City, words like “intelligent” (Mortensen et al., 2013, p. 3) or “operating in a forward-looking way” (Giffinger et al., 2007, p. 11) are often used. Some approaches tend to minimize the dimensions of the Smart City by mainly referring to the intended result of Smart City initiatives, but the Smart City is very complex and comprises much more characteristics. Probably the most important feature is the employment of ICT in the Smart City. Barrionuevo and his collaborators concisely define a Smart City by „using all available technology and resources in an intelligent and coordinated manner to develop urban centres that are at once integrated, habitable and sustainable“ (Barrionuevo et al., 2012, p. 50). ICT is considered to be the most important tool for a Smart City also by consulting companies such as: Arup, Copenhagen Capacity, Forrester Research as well as Correira and Wüstel (IBM Corporation, 2013). For instance, in order to ensure a secure energy supply, the Smart Grid makes it possible for grid operators to receive data about the consumer’s consumption. Not having the possibility to instantly exchange information will turn the idea of a grid into a not feasible one. Similarly, IP networks are considered by Alcatel to be essential in communication between different components and stakeholders (Alcatel-Lucent, 2012). Sensors or smart meters as tool for measuring a city’s operation are also important for Smart Cities alongside ICT in general. The wide range of intelligent systems can examine the information received and the activities and react promptly to precise situations. For instance, by monitoring traffic jams, a traffic guidance system can redirect traffic streams and recommend alternative routes (Dirks & Keeling, 2009; Mortensen et al., 2013). Equally important is the involvement of citizens. Their opinions on political decisions and aspects of everyday life are obviously important, but the involvement of citizens offers additional knowledge and experiences and can help in the development of smart concepts (Buscher et al., 2010; Mortensen et al., 2013; Wood Holmes, 2010). Scholars Chourabi and his collaborators, stress the importance of integrating and enabling communication between the totalities of systems within the city. Precisely, by connecting all sub-systems within the city it is created a “system of systems” (Chourabi et al., 2012, p. 2290). When we analyse the attempts to define the concept, we cannot prioritize the definitions, because despite the distinctions between them, they complement each other. The intrinsic features of a

Smart City help cities to develop better strategies and improve their operations. At the same time it is maintained an open approach towards their applications, in contrast with the definitions that tend to narrow down the areas of interest within Smart Cities. Therefore, by associating the two approaches, the constitutive features are more easily applied to specific areas of interest within Smart City. For instance, by implementing ICT technology within a Smart Governance framework it helps authorities to gather citizen’s opinions throughout social media instruments.

### 2.1. The Smart City Framework

The literature review revealed two ways of characterizing a Smart City. The first one is based on a set of intrinsic features and the second one was determined by the variety of interest areas that can compose the foundation of the Smart City. Starting from the different areas related to the Smart City, we can also distinguish a series of sub-areas. In the literature review could be identified various key features, precisely ICT employment, utilization of sensors and actuators to measure city activity, citizens’ involvement and the association of the different systems into a system of systems. In the following section will be identified the most important Smart City focus areas. Figure 1 presents no less than 17 distinct focus areas each one with its own functions and components.

Smart City focus area	People	Economy	Governance	Environment	Living	Mobility	Infrastructure	Government	Healthcare	Education	Energy	Social Services	Policy	Safety	Technology	Water	Organization
Frequency mentioned	12	11	11	10	10	10	7	5	5	4	4	4	3	3	3	3	1

Figure 1. Smart City focus areas in literature

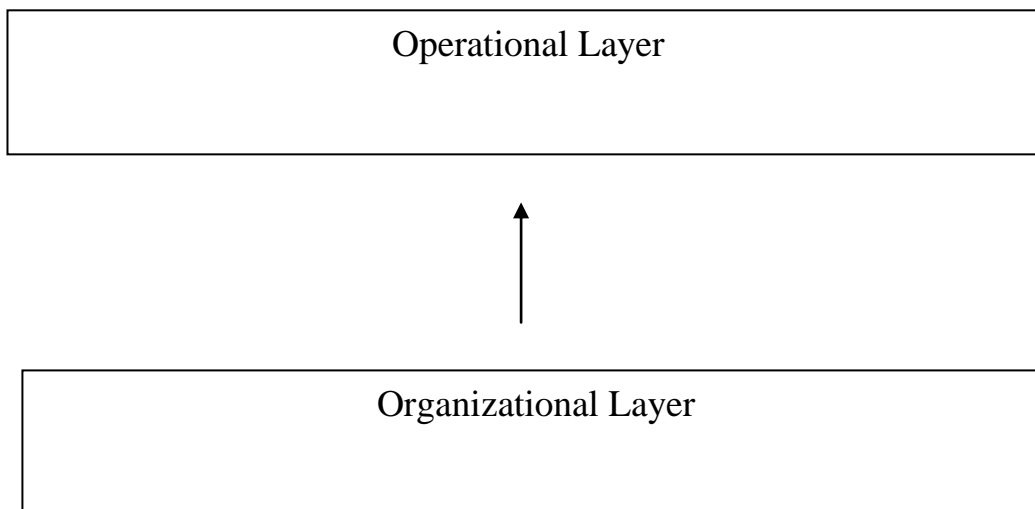
Source: authors’ own research

	Author	Focus Area	Components							Services										
			Governance	Economy	People	Environment	Infrastructure	Policy	Technology	Organization	Mobility	Government	Living	Energy	Water	Healthcare	Education	Safety	Social Services	ICT Foundation
Universities	Chourabi et. al. <sup>1</sup>		x	x	x	x	x	x	x	x										
	Thuzar <sup>2</sup>			x	x	x	x	x										x	x	
	Kourtit et. al. <sup>3</sup>		x	x	x	x	x												x	
	Barrionuevo et. al. <sup>4</sup>		x	x	x	x	x												x	
	Lombardi et. al. <sup>5</sup>		x	x	x	x							x						x	
	Tranos and Gertner <sup>6</sup>		x	x	x													x	x	
	Nam and Pardo <sup>7</sup>		x	x	x	x	x				x		x						x	
	Giffinger et. al. <sup>8</sup>		x	x	x	x					x		x							
	Batagan <sup>9</sup>										x	x			x	x				
Companies	Copenhagen Capacity <sup>10</sup>		x	x			x	x	x		x	x	x					x	x	
	Wood Holmes <sup>11</sup>		x	x	x	x					x		x						x	
	Alcatel-Lucent <sup>12</sup>		x	x	x	x					x		x						x	
	Frost & Sullivan <sup>13</sup>		x		x		x		x		x		x	x						
	IBM <sup>14</sup>				x	x					x	x	x	x	x	x	x	x	x	
	Alcatel-Lucent <sup>15</sup>										x	x	x	x	x	x	x	x	x	
	Forester Research <sup>16</sup>										x	x	x	x	x	x	x	x	x	
	Sum		11	11	12	10	7	3	3	1	10	5	10	4	3	5	4	3	4	12

Figure 2. Smart City focus areas by author type

Source: authors’ own research

Further on, three different groups of researchers stand out; researchers from companies focus on certain services brought by the city to its citizens (see Figure 2), while researchers from universities concentrate on specific entities or actors within the city, for example the people or the economy. The Operational and Organizational Layer represents the Smart City areas of interest which characterises the range of services offered by the city to its citizens and establishes the city's everyday state.



**Figure 3. Operational and Organizational Layer**  
 Source: authors' own research

By combining the other two components, the ICT Foundation and the Organizational Layer are created the services for the population. The most popular Smart City areas of interest are presented in Figure 4.

Smart City focus area	People	Economy	Governance	Environment	Living	Mobility	Infrastructure	Government	Healthcare	Education	Energy	Social Services	Policy	Safety	Technology	Water	Organization
Frequency mentioned	12	11	11	10	10	10	7	5	5	4	4	4	3	3	3	3	1

Operational Layer

**Figure 4. Focus areas on the Operational Layer**  
 Source: authors' own research

Many of these areas are services provided by the authorities and their partners. For instance, for the mobility function, the infrastructure for cars, bikes and public transportation must be supplied by the municipality. Similarly, the responsibility for education, healthcare, social services, energy, water, security lies with the government. Moreover, the United Nation considers and proclaimed most of them human rights, for example education, healthcare or social services (United Nations, 2013). Others such as security, water or energy are indicators for the quality of life. Even though government can be considered an organizational entity, because its main attribution is making decisions for citizens it is clearly a service for the population.

The Organizational Layer is the one dealing with the nature and feature of the entity governance. Compared to the Operational Layer, it is more difficult to articulate a definition for the

Organizational Layer because the latter includes a specific set of focus areas and not a variety of areas of interest that vary according to a certain city. Smart living presents and characterises the living conditions in general and, by default, people’s quality of life. The Organizational Layer comprises four different categories as focus areas, all presented in Table 1: **Smart Economy, Smart People, Smart Governance and Smart Living**.

**Table 1. The Organizational Layer**

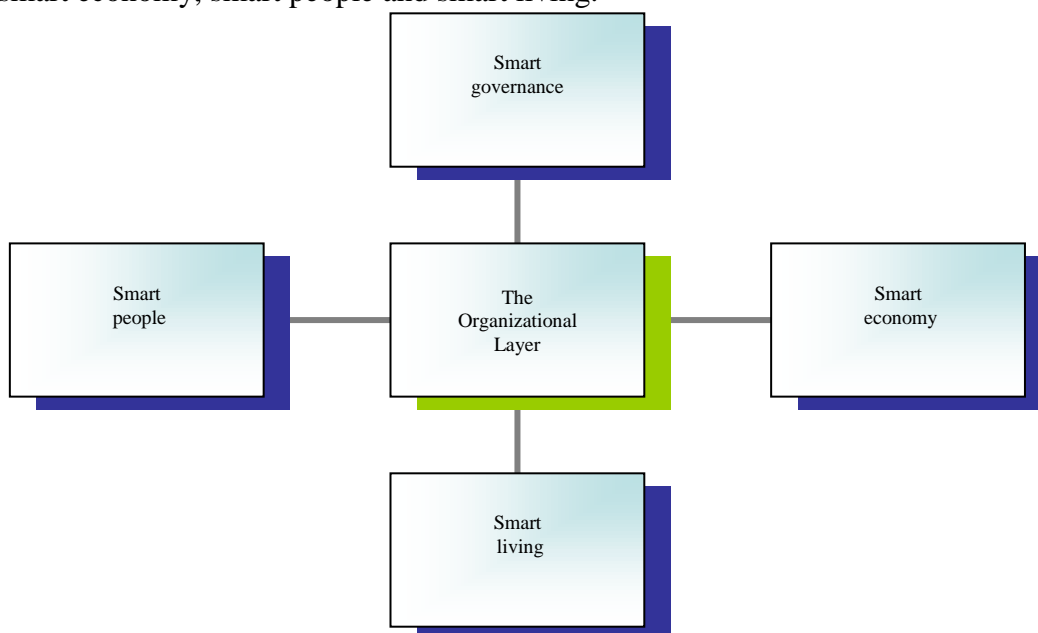
<b>Governance</b>	<b>Economy</b>	<b>People</b>
<b>Living</b>		

Even though every one of these areas of interest can independently function, it is very important that they cooperate to create and develop better smart solutions. Smart Living creates the foundation for a Smart City. It brings together basic living conditions so that decisions-making actors don’t have to worry about fundamental decisions and instead focus on forward looking Smart City concepts. A Smart Governance is founded on an organization that combines processes and structures that enable and contribute to a better cooperation and a more efficient decision-making. Therefore, cooperation between the government, the economy and its citizens is essential for Smart Governance. The complete Smart City Model consists of two layers and can be observed in Table 1. Moreover, the basis of the Operational Layer and the Organizational Layer is developed by the ICT Foundation. The Organizational Layer helps and facilitates the Operational Layer which provides the key Smart City solutions. The main objective of this study is to examine Copenhagen as a Smart City and in this respect the approach will be mainly organizational.

**2.2. The Organizational Layer of a Smart City**

Before studying the Organizational Layer of a city one must firstly understand the basic components that embody this layer in particular. In order to correctly to identify the main indicators (in bold letters) characterising the status of each Smart City focus area on the Organizational Layer I have reviewed the existent literature on topic. The indicators identified will be briefly presented in the final part of this section.

The most important elements that constitute this layer are: smart governance (Belissent, 2011), smart economy, smart people and smart living.



**Figure 5. Elements that constitute the Organizational Layer**

*Source: authors’ own research*

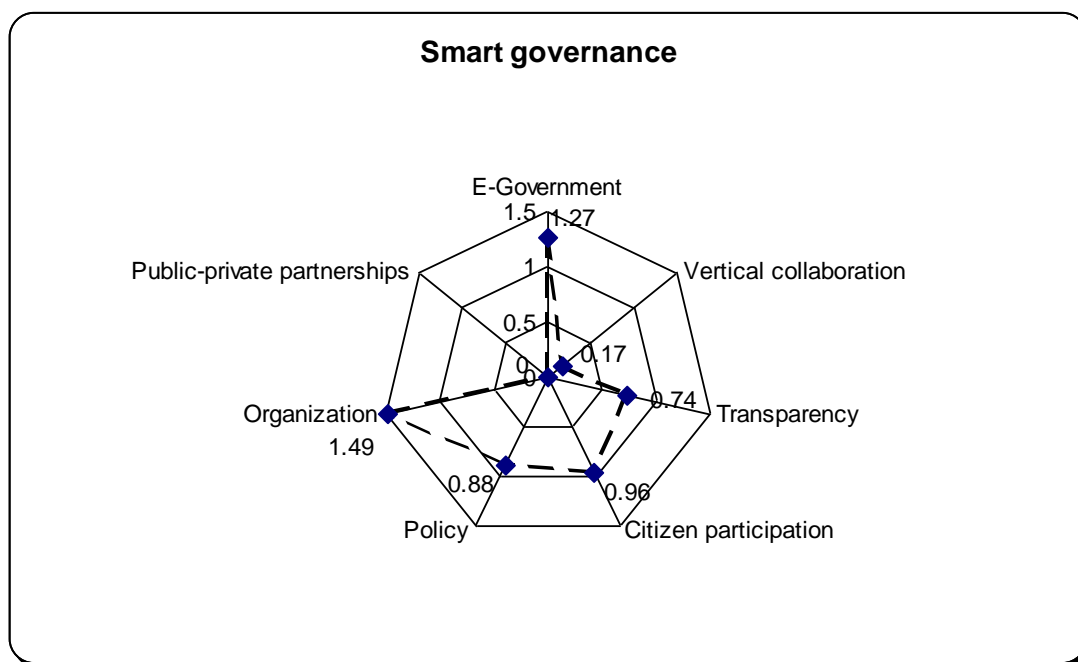
Smart governance means mainly the organization of the municipality, referring especially to the involvement of citizens into decision-making, transparency, e-government, public-private partnerships as well as the collaboration between various governmental layers. Last but not least, urban policy is a tool that leads to smart governance (Chourabi et al., 2012). As far as smart economy is concerned, this is generally characterized by a high employment degree, high productivity ranks, important technological innovation, constant entrepreneurship development (Tikhomirova et al., 2011) and the environment impact, that is enhancing a green economy. Also, knowledge-based economy can be seen as a major factor for smart economies (Gilmore, 2013).

Another key element of the Organizational Layer are the citizens, seen as smart individuals. Generally they are referred to in this context of life-long learning, with major accent on education and creativity. Thus, they need to be computer literate and characterized by open-mindedness as well as free will to participate in public life (Carter, 2010).

The last important element of the Organizational Layer is smart living, which refers mainly to several factors dealing with housing, health, safety, leisure (culture) as well as wealth (poverty), life satisfaction in direct correlation with the environment as a life quality factor (Malik, 2013).

### 3. FINDINGS OF THE RESEARCH

*Smart Governance.* There are seven indicators regarding government operations and transparency in communication with individuals.

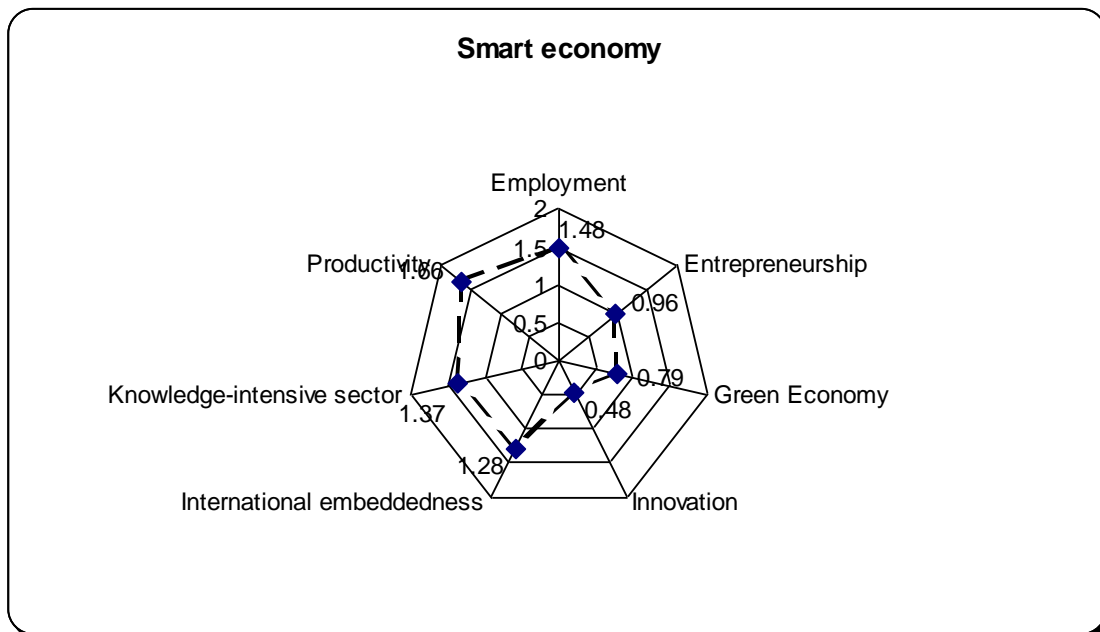


**Figure 6. Quantitative findings – Smart Governance**

*Source:* authors' own research

The highest ranks are those of organization, namely 1.49 and of E-government, reaching 1.27. The desire of citizens to participate in public life summed up 0.96, urban policy reached a level of 0.88 meanwhile transparency amounted to 0.74, The lowest level is registered by vertical collaboration, with 0.17. For one indicator, that is public-private-partnerships appropriate statistics could not be found. The average registered by Copenhagen at *smart governance* reached a value of 0.92.

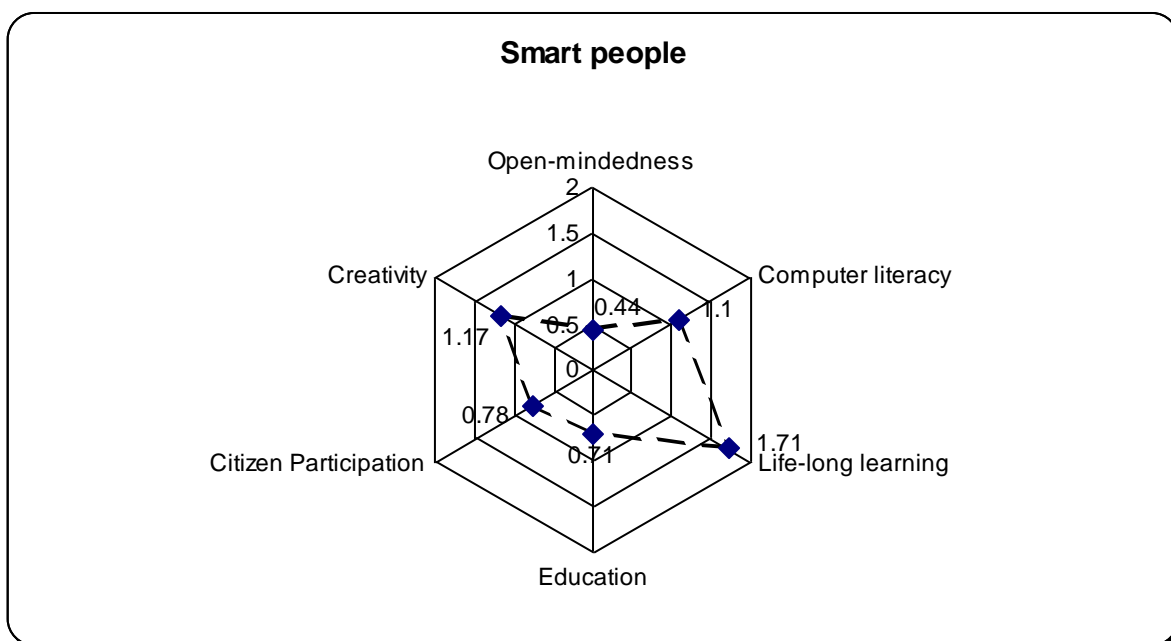
*Smart economy.* There are seven indicators regarding the smart economy, all of them describing the current state of the economy and its future prognoses.



**Figure 7. Quantitative findings – Smart Economy**  
 Source: authors' own research

The highest ranks are those of productivity, namely 1.66 and of employment, reaching 1.48. The knowledge intensive sector summed up 1.37, international embeddedness reached a level of 1.28 meanwhile entrepreneurship amounted to 0.96. Green economy reached 0.79. The lowest indicator is registered by Innovation, with 0.48. The average registered by Copenhagen at *smart economy* reached a value of 1.15.

*Smart people.* There are six indicators regarding the smart people, all of them describing the citizen's skills and mindset.

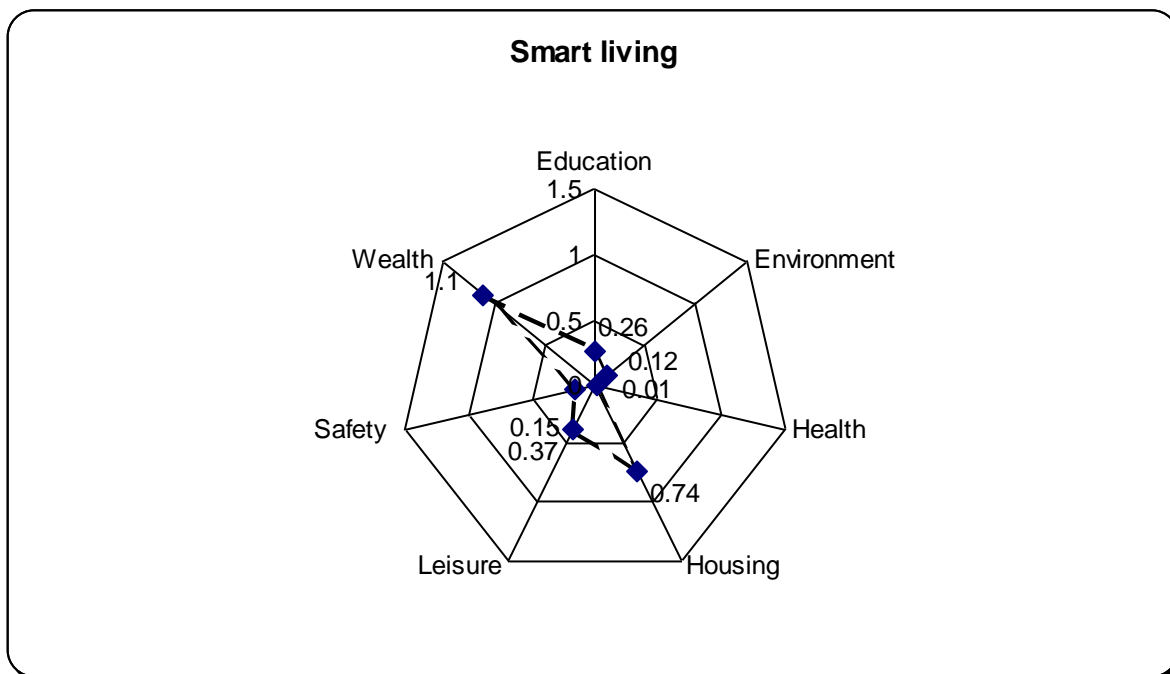


**Figure 8. Quantitative findings – Smart People**  
 Source: authors' own research



The highest ranks are those of life-long learning, namely 1.71 and of creativity, reaching 1.17. The computer literacy summed up 1.1, education reached a level of 0.71 meanwhile citizen participation amounted to 0.78. The lowest indicator is registered by open-mindedness, with 0.44. The average registered by Copenhagen at *smart people* reached a value of 0.99.

*Smart living.* There are seven indicators regarding the smart living.



**Figure 9. Quantitative findings – Smart Living**

Source: authors' own research

The highest ranks are those of wealth, namely 1.1 and of housing, reaching 0.74. The knowledge intensive sector summed up 1.37, international embeddedness reached a level of 1.28 meanwhile entrepreneurship amounted to 0.96. Green economy reached 0.79. The lowest indicator is registered by health, with 0.01. The average registered by Copenhagen at *smart living* reached a value of 0.92. The overall results of the research give as final value 0.86, after calculating the average of smart governance, smart economy, smart people and smart living. According to the findings, Copenhagen is a smart city especially because its citizens are constantly preoccupied by the quality of life through intelligent solutions. Thus, projects implying smart development are accepted by individuals and promoted by government. At the same time, citizens from Copenhagen are fond of life-long-learning, and, in addition to this, they are willing to participate to public life. Also, a high cultural level is synonymous with a smart city. In addition, the mentality of citizens can lead to the promotion of the right solutions for stakeholders. People from Copenhagen are willing to get involved into the local projects, which mean that they are close to the city government. These indications combined are favorable to Copenhagen. Another feature that could be observed was the advanced e-government competence, which, together with a high level of individuals' participation lead to an easier digitalization of the infrastructure of Copenhagen.

#### 4. CONCLUSIONS

The conclusions provide answers to the two questions of the study, at the same time offering a framework of the most important findings. The answer to the first question "Is Copenhagen a Smart City?" according to the research findings is that Copenhagen is, indeed a smart city. The major

reasons for concluding this are that according to the quantitative review, Copenhagen surpasses the average in all sectors. At the same time, as already seen, the score achieved by Copenhagen reached 0.86 in total. As a consequence apparently there are no major drawbacks for Copenhagen regarding the various sectors that characterize a Smart City. It should be however emphasized that only the organizational Layer of Copenhagen was taken into account, which could represent a limitation of the hereby research. At the same time, it needs to be mentioned that the studied Layer has a major impact on the rest of the layers, which could have lead to similar results.

Since the answer to the first question was yes, the answer to the second question "What makes Copenhagen smart?" can be further developed. Thus, starting from the features identified in the quantitative analysis, it becomes clear that the main reason for considering Copenhagen a Smart City is represented by the mentality of the citizens particularly because it is synonymous with the targets of a Smart City. For the inhabitants of Copenhagen a high quality of life is very important and that is highlighted in all areas of interest. Precisely, within Smart Economy, companies in Copenhagen succeed in developing business models which serve and support the whole society and not the company itself; within Smart Governance, the main goal is to increase the quality of life and around this goal is built the governance strategy; when concertized these attitudes and actions assure a high quality of life, supporting the Smart Living indicator. Therefore, it has become clear that in the heart of the Smart City Copenhagen are its citizens. Another interesting fact is that another factor promoting Smart City development is that citizens empower their city to act on their behalf and precisely this delegation of powers leads to better decisions, closer to citizens. Additionally, by actively taking part to public life, sharing their opinion, they can influence the decision-making process. Again, this proves the interest in a high quality of life. These three elements, mentality, local decision-making process and citizens' involvement are the key factors that help Copenhagen to be efficient by implementing the appropriate projects when and where those are mostly needed. This sense for smart initiatives would also be crucial for other cities. Nonetheless, despite its strong features, Copenhagen also has weaknesses. In the following I will briefly present the main challenges Copenhagen has to overcome. Government work is rather fragmented; some departments continue to be separated. Moreover, despite the fact that they are a foundation of government's strategy execution, building public-private-partnerships is still posing challenges. Additionally, insufficient collaboration between municipalities can determine an inconsistent net of municipalities without integrated solutions.

Therefore, it is recommended for Copenhagen to continue their development as a Smart City and, at the same time to work on improving governmental collaboration. Also, the administration must focus on finding lucrative solutions and start building more and stronger public-private-partnerships. Hence, in order to ensure adequate strategy execution one must carefully examine and identify all determining elements. Further, either within Copenhagen or at the regional level, internal government structures should resolve their issues and find a solution for integrating municipality plans. Doubtless, other solutions to amend cross-municipal collaboration can be analysed and applied.

In the end, we consider Copenhagen as a smart city to be both a successful project, form the point of view of a city feasible development, and also a good example to be followed and to be implemented in various cities around the world, including Bucharest.

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