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A Literature Review of Smart City: Concept and Framework

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Abstract - Research on smart city building evaluation has been undertaken in countries with earlier IoT technology development since the notion of smart cities was established. Smart city evaluation is an important component of smart city development and plays a key role in guiding and encouraging city development. Existing smart city evaluation research and applications are now in the exploratory phases. The previous study defines a series of smart city frameworks and smart city modules. Through our research, we need to answer the fundamental question, how is a smart city evaluated and concept? This paper aims to shed light on the smart concept and how to evaluate the smart city conjunction, structures, and elements. RStudio-biblioshiny used for bibliometrics analysis then makes diagramed for each concept and evaluated. This article offers a well-integrated, ubiquitous, and highly extendable assessment system based on a common smart city framework. Then based on the above assessment approach, ten universal smart city frameworks were evaluated in 26 articles, while included from 2363 articles; this review illustrates how the assessment system is helpful for better understanding the entire architecture of smart city platforms, making comparisons, and creating standards among smart cities. Indicator comparisons show that future smart city building should prioritise citizens, innovative technologies, the development of dynamic information resources, and spatiotemporal big data.

Keywords - *Smart city, Evolution, ICT, Smart city framework, Infrastructure*

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1. Introduction

Smart cities use information and communication technologies to improve the quality of life for their residents, local economy, infrastructure, traffic management, climate, and engagement with the government (Lim, Edelenbos, and Gianoli 2019). Smart cities combine other terms like DataCity, Intelligent City, City of Knowledge, Ubiquitous City, Wired City (Ismagilova et al. 2019).

Research on smart city building evaluation has been undertaken in countries with earlier IoT technology development since the notion of smart cities was established (Li et al. 2020). The World Smart Cities Organization, Harvard University's Center for International Development, international corporations like IBM and International Data Corporation (IDC) in the United States, and universities such as the Vienna University of Technology have also performed studies (Mora, Bolici, and Deakin 2017). Countries like the United States, Italy, Japan, and China have conducted smart city development evaluation studies (Intelligent Community Forum 2008; Komninos 2009; Li et al. 2020). The previous studies showed that many technical standards and design issues are daunting. There were reliable research and development that referred to technology-based besides an open flow of data and participatory service design play an essential role in increasing the public involvement of a community (Lee, Hancock, and Hu 2014; Brandt et al. 2016). A series of smart city frameworks and smart city modules are defined during the previous study. Most countries are interested in smart cities, but money can not apply to smart cities because there are many cities, and each city has different functions and different stakeholder requirements (Anna Visvizi and Miltiadis D. Lytras 2019).

Considering the smart city concept, through the interconnection of elements, such as water, electricity, transport or infrastructure (Srivastava and Mostafavi 2018), the city's main functions and citizen requirements real advantages can create (Chaturvedi et al. 2019). Now, the main question is how smart city evaluated and concept? The current study aims to analyse the research published on the smart city. Through the analysis, we need to answer this question, assess and concept of a smart city from the previous study, and evaluate projects.

This paper aims to shed light on evaluating cities' requirements to become smart and how to consider the smart city conjunction, characterised and elements. The aspect of the study searched the literature that allowed us to understand the series of factors described by researchers to create smart cities framework and models, used RStudio-biblioshiny for bibliometrics analysis. The second stream of study focused on classifying the smart city frameworks, modules, and elements accepted by previous researchers, then drawing diagrams

to explain each of their existing concepts. We mapped the literature to understand what lessons we learned from the past, discuss future city requirements, and finally provide a future agenda.

There are five sections; the second section is the Methodology of our systematic literature review of this paper, the descriptive analysis of SLR, and the third section about the Bibliography analysis used RStudio biblioshiny, which explains the report and results of SLR about smart city. The fourth section is about the evaluation and concept of a smart city from the previous studies and drawing for each concept. The fifth section is about the results and discussion, then consultation.

2. Method

We developed a search strategy to identify relevant literature for this systematic search. This search strategy was tailored to two databases: Scopus and Web of Science; the search terms used were: “Smart city” OR “Smart city concept” OR “Smart city evaluation”. All searches spanned from database inception until 2021 and included journal articles, conference papers, review papers are published in English only.

The selection criteria were based on the PRISMA statement (Moher et al. 2009). The search mainly focused on mapping existing literature on smart cities in social sciences, environmental sciences, economics and finance, computer science, business management and accounting. The search then narrowed to the subject areas, including environmental science, social science and computer science. The search span was from 2011 to 2021, and 19 additional articles from other sources and years.

The search was mainly focused on all countries; thus, articles from all countries were included. Of 2363 articles, 2243 remained after duplicated records were removed, while 2134 articles were excluded at this stage after the screening. After the filtration of documents, 384 more articles were removed from the study. There were 109 records extracted at this stage.

The study is based only on original research articles, review papers, and conference papers. To maintain the quality of the review, all duplications were scrutinised. Abstracts of the articles were checked deeply to analyse and purify the articles to ensure the quality and relevance of academic literature included in the review process. A careful evaluation of each research paper was carried out later. The following exclusion criterion was limiting the documents published in English only. There was (3) article in the non-English language excluded from the study.

Studies included in the qualitative assessment, 31 articles were selected and the characteristics extracted were:

1. The article must be an original paper, a review paper and a conference paper; published reports, case studies were excluded.
2. The article must be in the English language and from the field of social sciences, business and economics, environmental science, and computer science.
3. Extracted articles were published between 2011 and 2021, and some external articles from 2007 to 2021.
4. The extracted papers were from all countries.

In the data extraction phase, we selected 26 articles after assessing each article on the inclusion and exclusion criteria, shown in Figure 1 (PRISMA statement).

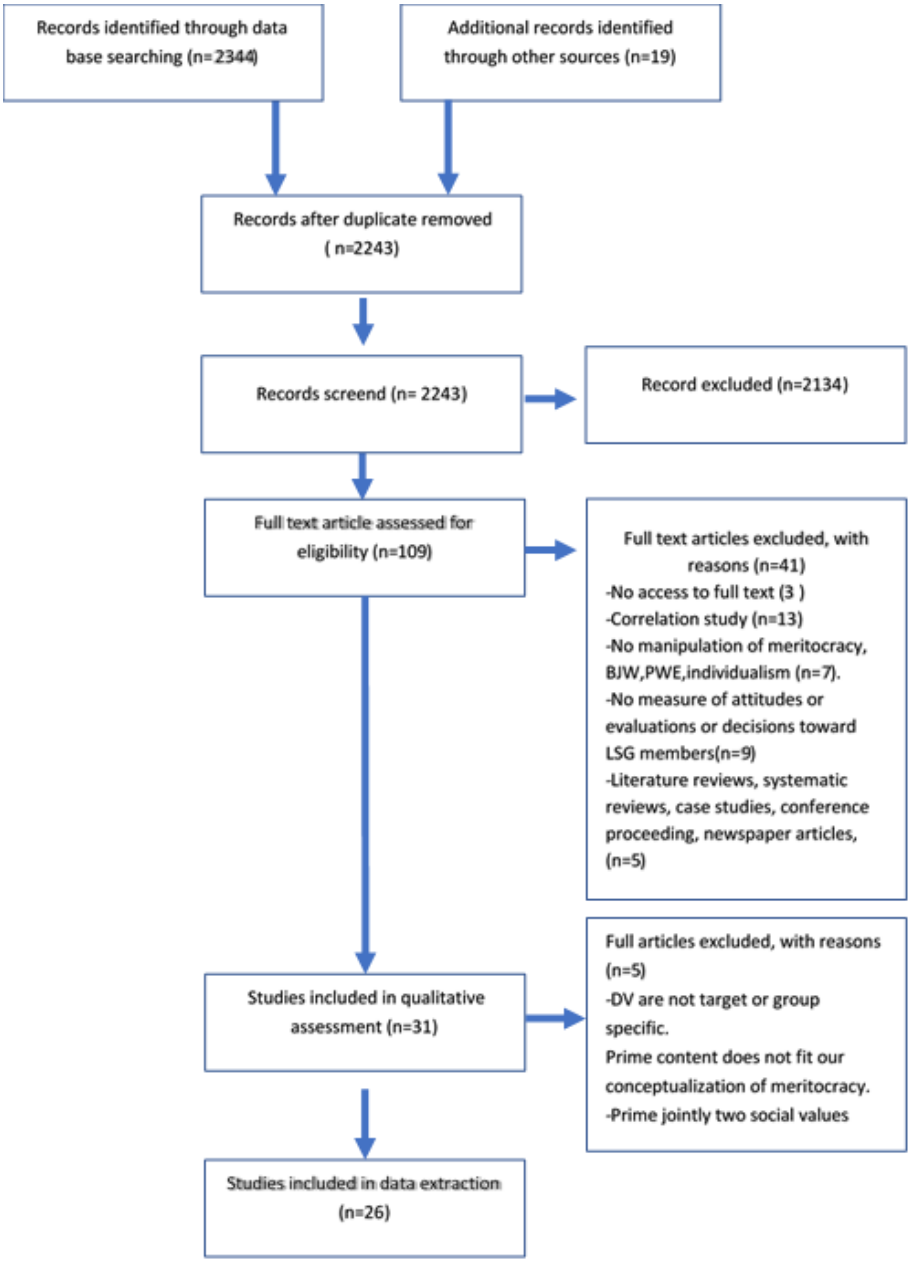

Figure 1. The literature inclusion and exclusion at every stage.

3. Reporting Results

R is a computer language for comprehensive science mapping analysis tool for quantitative research in scientometrics and bibliometrics (Aria and Cuccurullo 2017). Through RStudio using biblioshiny command, the results reported:

Title Content: Through word cloud, by drawing a map that there is a title of the article's interrelationship and internal connection between smart city concept, smart city evaluation and smart city application, this gives us good feedback for our papers. As presented in Table 1, the

most frequent terms that appeared in the title of the articles are “Smart cities concept”, “Smart city evaluation”, and “Smart city applications”. At first, the text analysis we performed returned; as a result, various terms relating to common concepts (“Smart city evaluation” and “Smart city concept”). So after the data set retrieval from the Scopus and Web of Science databases, we had to do some pre-processing work such as N-Grams, Number of Words, Word occurrence measure of the documents through biblioshiny inside RStudio comprehensive science mapping analysis, document selected word cloud, ignore numbers and disregard case sensitivity. Figure 2 shows the word cloud constructed by the terms.

Table 1. The frequent term that appeared in the title of the articles.

Terms	**Frequency%**
smart city concept	28%
smart city evaluation	16%
smart city concepts	11%
smart cities concept	8%
smart cities concepts	5%
smart city evaluate	4%
smart city applications	13%
smart city development	4%
smart city projects	7%
smart city context	1%
Others…	3%
Total	100%

Figure 2. Word cloud constructed by the terms from Rstudio.

Dataset: A three-field plot (Sankey diagram) of the title, abstract, and country of publication of the cited references depicted the proportion of research topics for each country and the recency of the paper's content. As shown in **Error! Reference source not found.**, the significant interests of smart city researchers in Indonesia. The dominant research topic in Italia, then the USA, is smart cities and urban. Indonesia, the USA, China, and Spain have published most of the discussed consent papers. India, Russia, and Germany have published research on smart cities and urban evaluation and development, though they are few in number.

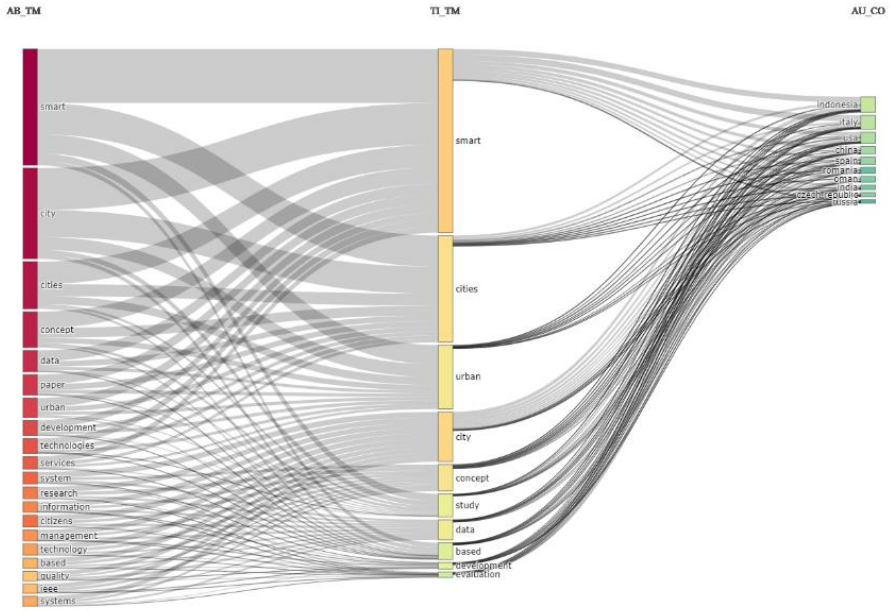

Figure 3. A three-field Plot (Sankey diagram) of Title, Keyword, and Country of publication of the cited references for the ten most researched topics.

Social Structure: Figure 3 shows the visual representation of the collaboration network between countries. We can see that the strongest edge appears between AUSTRIA and SOUTH

AFRICA, BRAZIL and MEXICO, and IRAN are the most productive countries in the research domain. The most productive countries appear in deep blue.

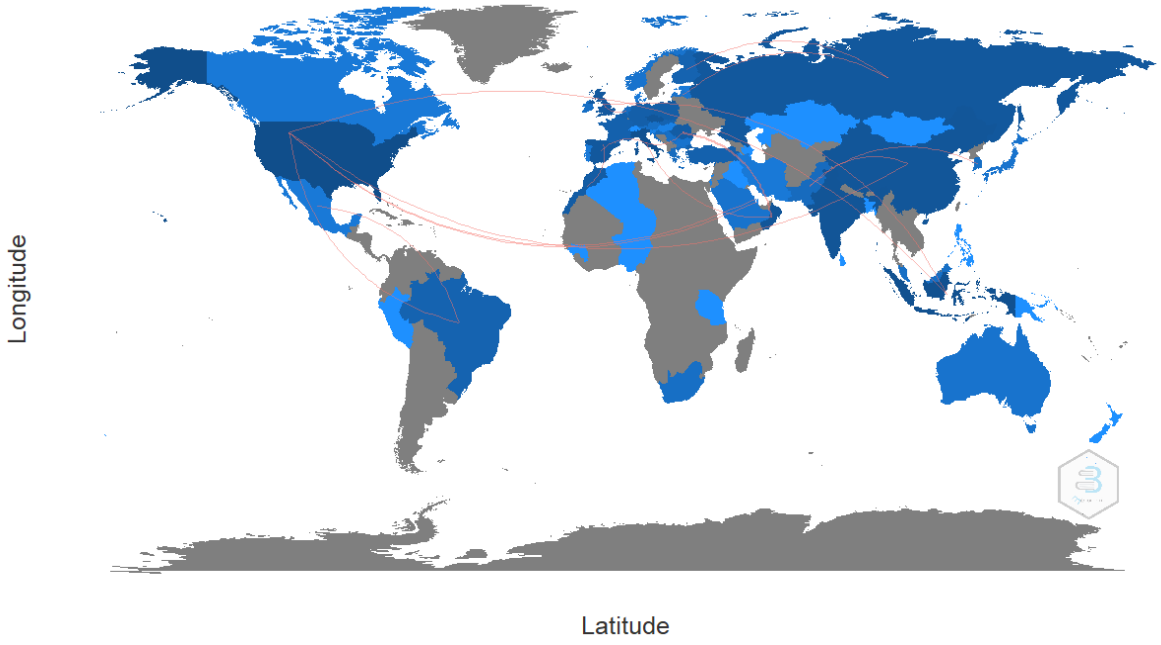

Figure 3. Representation of the collaboration network between countries from Rstudio.

4. Evaluation of Smart City

The Smart city is defined as a city that uses ICT, technology, and innovation advances to address urban issues, including improving the quality of life, promoting economic growth, developing a sustainable, safe environment and encouraging efficient urban management practices. This section reviews the evaluation of smart cities by authors and how they are evaluated.

Giffinger et al. (2007) created a system to evaluate smart city construction based on six aspects of intelligence, including smart economy, smart governance, smart living, smart citizen, smart environment, and intelligent mobility (refer to Figure 4).

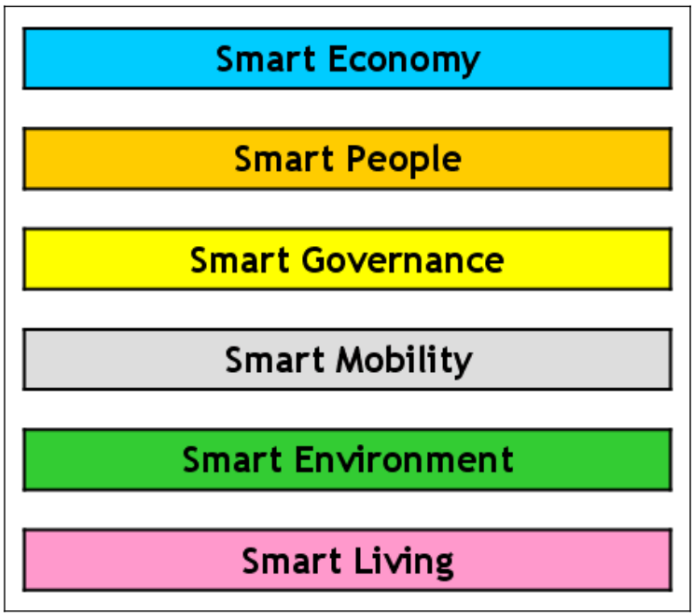

Figure 4. Characteristics of a smart city (Giffinger et al. 2007).

Global (et al., n.d.) IBM stated in 2008 that a smart city evaluation should include seven dimensions, including the people, business, government, transportation, communications, water, and energy of the city, according to the concept of a smart city. Caragliu, del Bo and Nijkamp (2011) recommended that smart city growth is linked to factors such as creative industries, urban environmental sustainability and understanding, public education levels, multimodal information accessibility, and government management's use of ICT. They proposed the creation of new ways to evaluate smart cities and strategic plans in Europe (Figure 5).

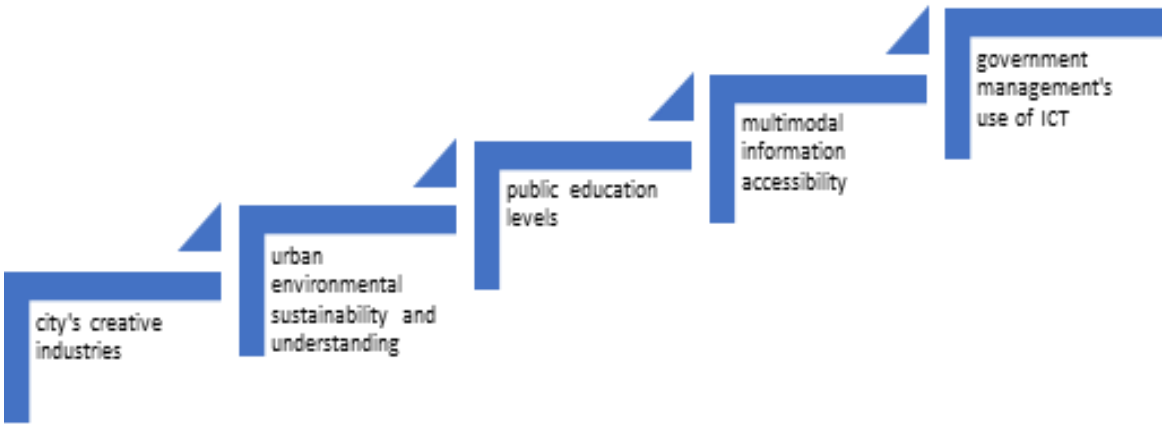

Figure 5. Smart City Growth Factors (modified from Caragliu, del Bo and Nijkamp, 2011).

Blumberg (2013) evaluated that the smart city concept is more than just an app; it is an information and application infrastructure for the city. Many correlations between urban planning and city growth, such as energy use and telecommunications networks. Better energy and communications networks are necessary when the population of a region or neighbourhood grows. Understanding and making decisions on city growth requires an in-depth knowledge of the telecommunications and energy networks (see Figure 6).

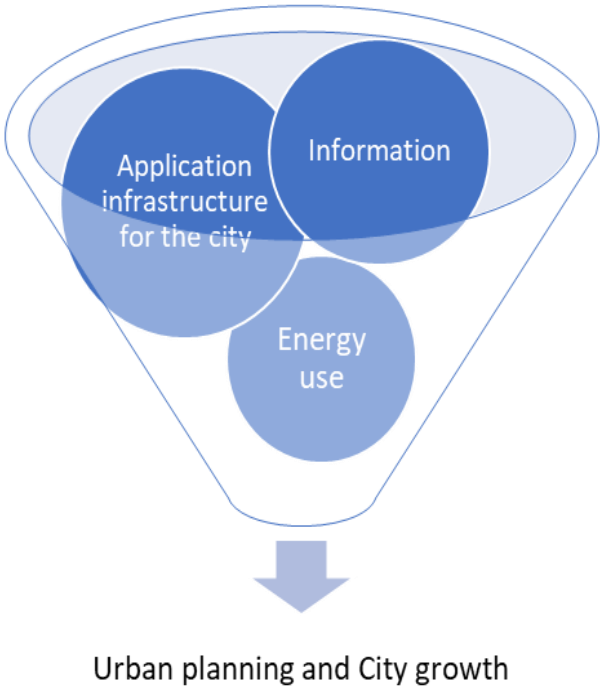

Figure 6. Blumberg's smart city concept (modified from Blumberg, 2013).

Roche (2014) evaluates a smart city that can effectively use technological advancements in a multidimensional area to predict, comprehend, freely discuss and serve a diverse range of actors. To achieve this, the smart city functions in four key dimensions: the intelligent city (its social infrastructure), the digital city (informational infrastructure), the open city (open government), and the live city (its physical infrastructure) (a continuously adaptive urban living fabric). Urban actors in today's era are both linked and mobile actors; they are no longer only consumers of urbanity but active participants in creating these smart cities. Citizens use a variety of abilities, including spatial skills. To do this, the commitment of these actors, especially their spatial commitment, is critical to the optimum functioning of the smart city's four dimensions, see Figure 7.

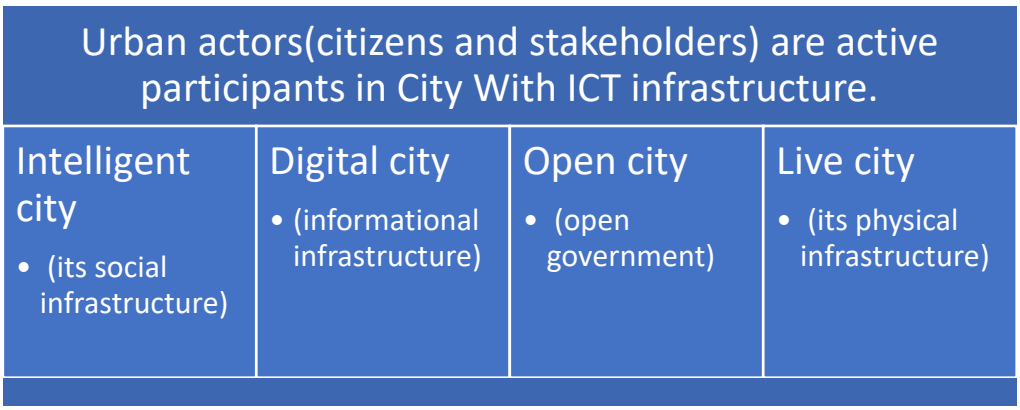

Figure 7. Smart city functions in four key dimensions (modified from Roche 2014).

This explanation includes information about a participatory approach, as enhancing problem-solving capabilities for urban communities can rely on the citizens' contribution. According to the "Smart City Model" developed by Doran and Daniel (2014), a smart city's goal is to integrate three major components: Economic Component, Environment Component and Social Component (see Figure 8).

Figure 8. A smart city's goal (modified from Doran and Daniel 2014).

Angelidou (2015) divided the smart cities' conjuncture of four forces, the recent history of smart cities, into two large sections urban futures and the knowledge and innovation economy. The urban futures strand showed that technology has always played a significant part

in futuristic views of cities. The knowledge and innovation economy revealed that recent technology developments had given cities a whole new level of knowledge management and innovation capabilities, as shown in Figure 9.

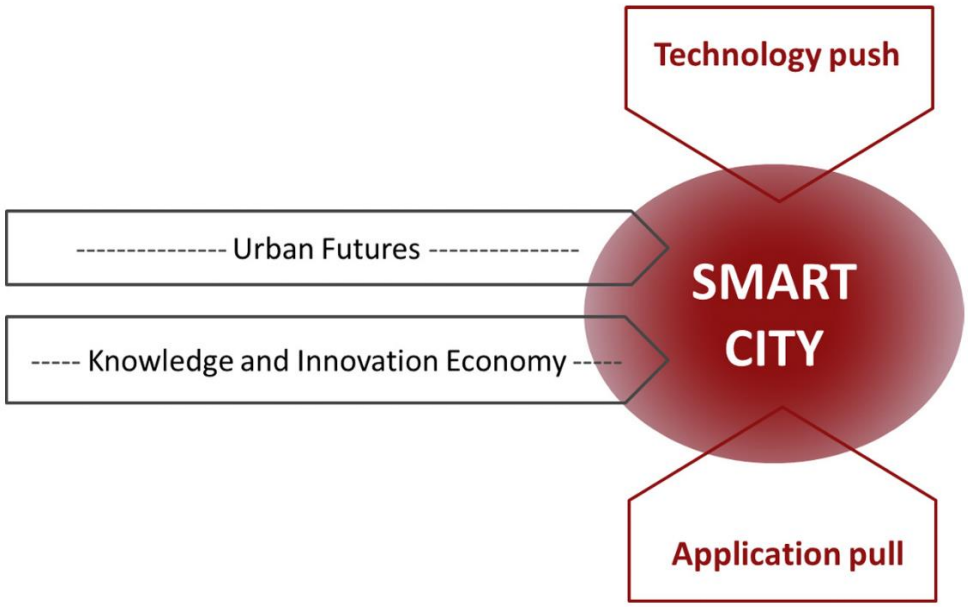

Figure 9. Smart cities; are a conjuncture of four forces (Angelidou 2015).

This evaluation method covers a wide range of reasonably comprehensive indicators, yet the conclusions are subjective because of the system's highly distinctive qualities in Europe.

Cohen and Muñoz (2015) analysed smart cities globally, using urban innovation and sustainable development as criteria and mentioning innovative cities, regional green cities, quality of life, and digital governments (Figure 10).

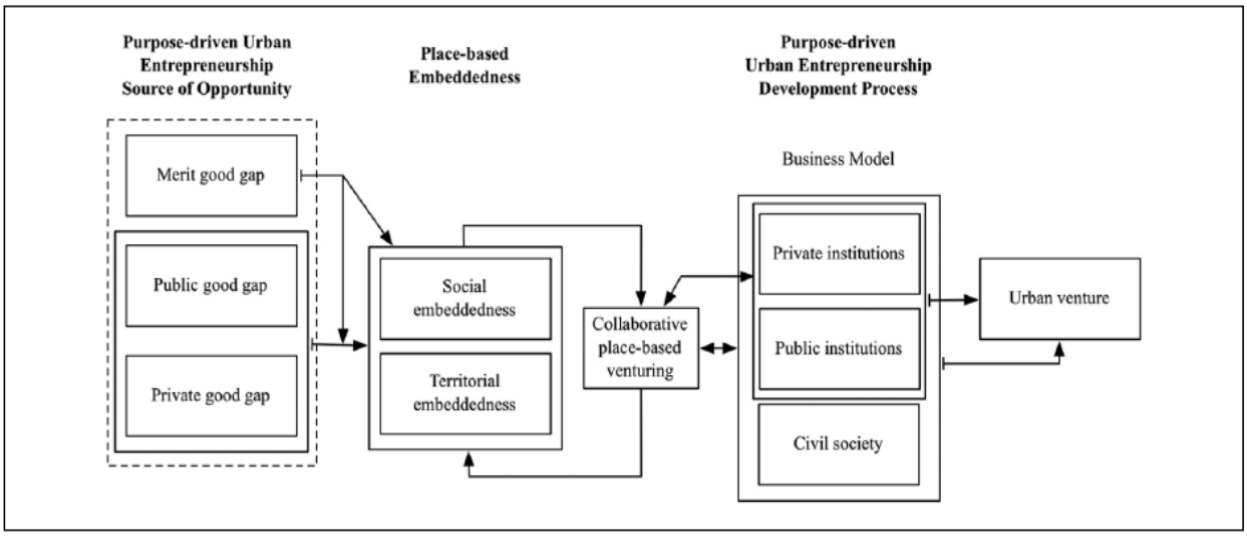

Figure 10. Chen analysed smart cities (Cohen & Muñoz 2015).

However, Al-Nasrawi, Adams, and El-zaart (2016) explained that the development of a smart city should be a dynamic process in which perpetually new solutions will be developed together with politics, administration, and economy be offered to the citizens or companies of a city. This description does not emphasise participation as part of the smart city development, even though it should be part of it by definition and vital to introduce, see Figure 11.

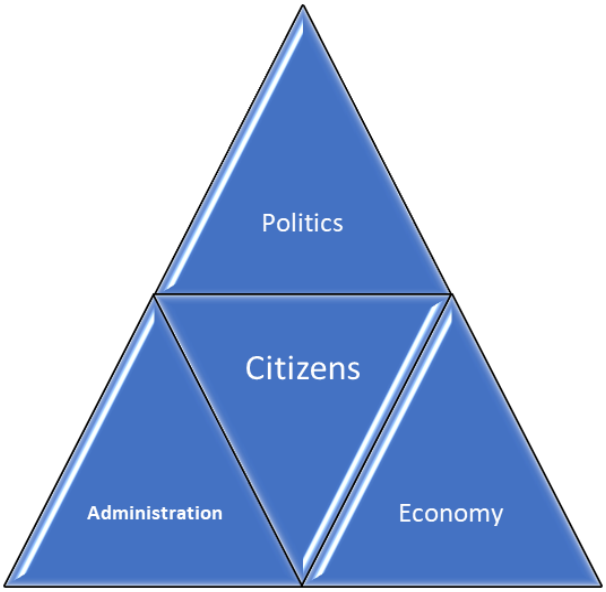

Figure 11. Smart city development (modified from Al-Nasrawi, Adams, and El-zaart 2016).

Stephenne et al. (2016) explained smart cities have the potential to modernise because "they are no events in the cyber-sphere but integrated social, physical, institutional, and digital spaces, in which digital components improve the functioning of socio-economic activities, and

the management of physical infrastructures of cities, while also enhancing the problem-solving capacities of urban communities", showing in Figure 12.

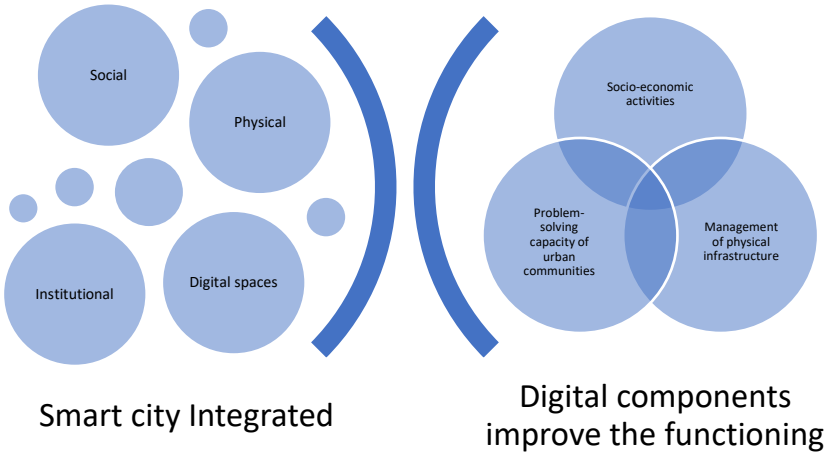

Figure 12. Smart cities modernise (modified from Stephenne et al. 2016).

Evaluating the main ten selected smart city frameworks depending on the factors and dimensions are explained by the authors. The diagram shows the chronologic of the authors, years and framework factors and dimensions are presented, from 2007 starting by Giffinger to Stephenne in 2016, shown in Figure 13. Giffiners explained six main dimensions of a smart city and Global-IBM details seven dimensions. Caragliu, delBo and Nijkmap explained their five dimensions, but others, like Roche, explained only four dimensions, while Cohen and Muñoz showed only four. Other authors explain and give details about the smart city as a different thing. Blumberg explains smart city as two factors, then Dorna and Doniel explain three components. At the same time, Angelidou details four forces, and Al-Nasrawi speaks about four dynamic processes. More than that, Stephenne et al. presented three integration, two components, and one problem solver. See summarise the chronology with a diagram for all authors in Figure 13.

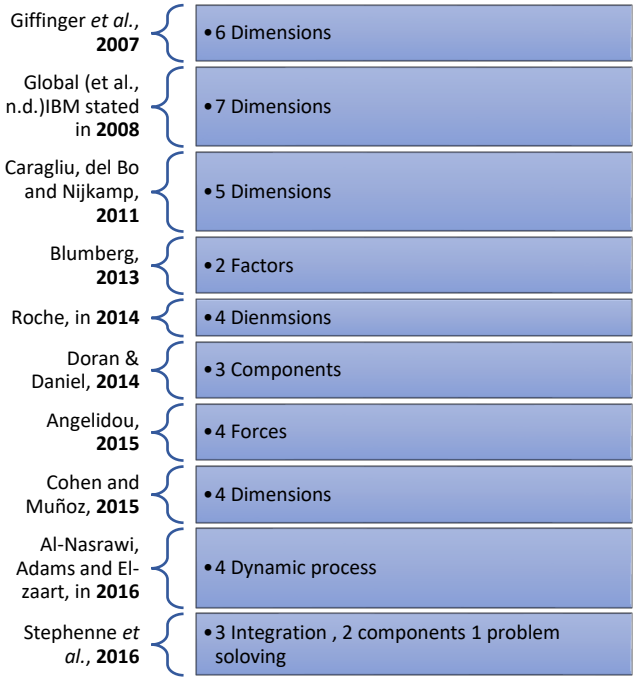

Figure 13. Chronology summarises framework dimension as "drawing by author".

5. Resulting and Conclusions

Many smart city projects are regional marketing activities, and the state of their impact or implementation on the city's launch is unknown (European Commission 2011). A further integrated, holistic, and multidisciplinary approach is required to investigate the interconnections between various regions and studies of the city. The ubiquitous and rapid expansion of information and communication technologies (ICT) has created instruments that can support this strategy or increase the efficiency of the city system (Ruano et al. 2016).

As the number of smart cities grows, it's more critical than ever to understand how to assess their construction levels. This study presents a well-integrated, global, and highly common evaluation system based on a shared smart city framework. The examination of the planned system is critical to comprehend the actual building scenarios of various smart cities compared to the same standard. The following are the main conclusions:

(A) This study provides guidelines for selecting smart city evaluation systems indicators based on theoretical considerations of a standard and shareable smart city framework. After that, a common, systematic, scalable, and efficient smart city evaluation method with ten significant

indicators. The system covers social infrastructure, information infrastructure, citizen, open government, physical infrastructure, and applications.

(B) Using the ten evaluated research, results show that the suggested approach makes it easier to grasp the actual building conditions of different smart cities around the world compared to the same standard, to make comparisons between evaluated frameworks or models, to discover their disparities, and to set benchmarks.

This article investigates a related smart city assessment method that may be used by various smart city frameworks or platform evaluations based on a shared smart city framework. The suggested approach is vital for comprehending the current construction circumstances of different smart cities worldwide. However, the evaluation system in this article focuses on assessing the sharable smart city framework and smart city technology systems development, which may leave it vulnerable to evaluating the interactions between human capabilities and technological systems.

From our study evaluating the smart city concept, four primary city functions depend on citizen requirements and availability of ICT; there is Intelligent City, Digital City, Live City, and Open City. These four primary types of the smart city combine Social Infrastructure, Physical Infrastructure, Information Infrastructure and Open Government (see Figure 14). As a result and conclusion of all framework studies, the authors' conceptual framework drawing is shown in Figure 15.

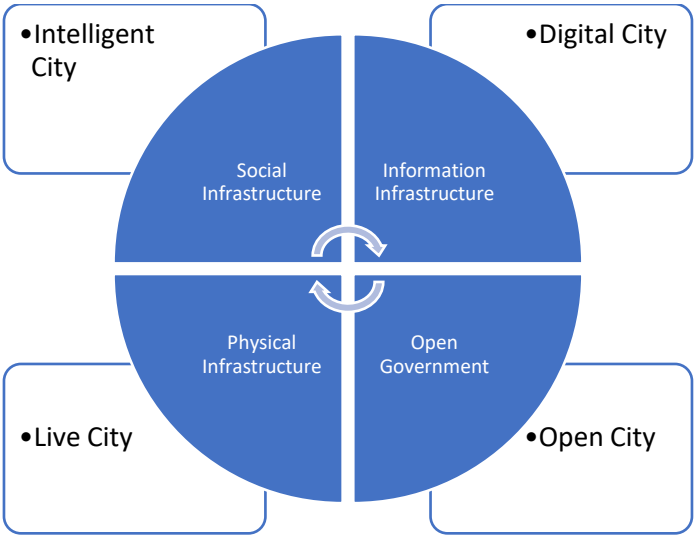

Figure 14. The smart city functions; four key dimensions.

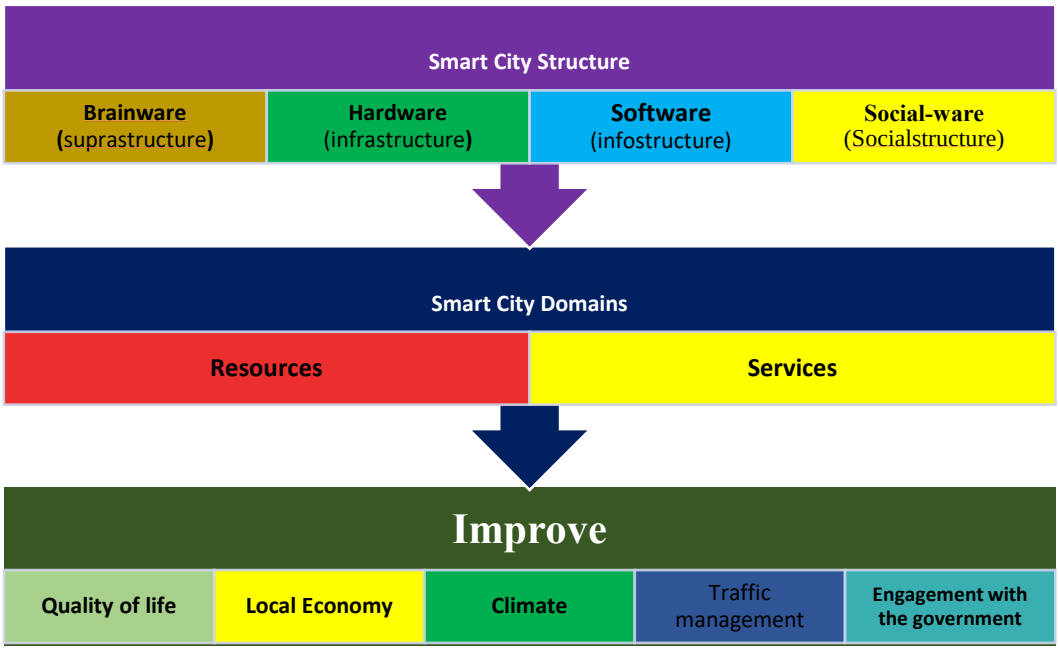

Figure 15. Smart city conceptual framework.

As a result, we will combine the evaluation indexes of some elements, skills, physical and geographical aspects in the future study to enhance smart city evaluation and assess the entire smart city development. As new technologies and data become available, more focus will be placed on updating and strengthening the assessment system to guarantee that smart city planning, design, and construction are more efficient and fair. The suggested method should evaluate additional cities in the future to make the system more realistic and to better understand the actual building conditions of various smart cities.

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