REQUISITE OF SUB-ATTRIBUTES FOR SMART CITY CONCEPTUAL FRAMEWORK

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Abstract

A smart city requires citizen participation and key metrics such as smart city elements and performances. This paper aims to identify the sub-attributes for smart city elements and performances that required the formation of the conceptual framework. This research has studied the past literature related to smart city studies and citizen's needs from the Smart City. This research continues the study by identifying two categories of variables which are Smart City elements and Smart City performance. The investigation of past literature shows that Smart City elements consist of eight attributes namely Administration, Social, Infrastructure and Utilities, Transport, Technology, Human, Economy and Environment. The result of past studies also determines that constructs that are important to Smart City performance are Quality of Life, Resource Management and Economic Competitiveness. To ensure the success of smart city initiatives, this study provides sub-attributes of smart city elements and performance that can assist policymakers and government in selecting the best criteria for sub-attributes for a smart city conceptual framework.

Keywords: Smart city, Sub-attributes, Conceptual Framework, Elements, Performance

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INTRODUCTION

The Ministry of Housing and Local Government in Malaysia recently launched the Smart City Framework as a guideline for developing smart cities (Cindi, 2019). Former Prime Minister of Malaysia, Tun Dr Mahathir, stated during the Second Cities 4.0 International Conference and Exhibition in Kuala Lumpur on 23 and 24 September 2019 the importance of integrating sustainable technologies into the city's services to improve community safety and quality of citizen's quality of life. Examples of sustainable technologies include autonomous public transportation, drone deliveries, 5G connection, cashless neighbourhoods, energy-efficient structures, intelligent water treatment and management, and others (Cindi, 2019). The smart city concept has generated a lot of debate among city planners, investors, and local government and attracted more affluent residents, law-abiding citizens, and potential investors. The most effective and efficient use of resources in daily life is another worthwhile topic. The availability of facilities, employment growth, and higher income chances contribute to the growth of the urban population compared to rural areas.

According to Mosannenzadeh and Vettorato (2014), the term 'smart city' refers to a sustainable and green city with excessively first-class lifestyles. The aim of a smart city is to address city challenges by enhancing mobility, optimising resource use, enhancing fitness and safety, improving social development, supporting economic growth, and including participatory governance. By implementing ICT on infrastructure and services, the collaboration of its key stakeholders (i.e., citizens, universities, government, industry), integration of its key elements (i.e., environment, mobility, governance, community industry, and services) and financial support for social capital could be achieved. To provide a more robust conceptual framework, this paper extended the research of Mosannenzadeh and Vettoroto (2014) and analysed the most recent literature review addressing the sub-attributes of elements and performances of smart cities.

The six sections of this paper are as follows: introduction, smart city conceptual framework, research methodology, discussion on sub-attributes of smart city elements and performances, discussion, and conclusion.

CONCEPTUAL FRAMEWORK FOR SMART CITY ELEMENTS AND PERFORMANCES

Smart city elements are the core subject of establishing a smart city concept. However, smart city performance is the main goal of smart city development. These performances will demonstrate the results that can be acquired by establishing the smart city concept. One of the techniques to assess the performance of the city is by using a modified Giffinger's model improvised by Yasmin et al (2016). The technique is easy to understand and apply in the case

study. Can refer to Yasmin et al (2016) work for more insight into assessing performance of the city by case study. Figure 1 shows a smart city conceptual framework that combines both smart city elements and smart city performances. Scholars have different perspectives on smart city elements. Accordingly, this study compiled the elements and performances from previous research and summarised them in Figure 1.

A smart city consists of eight (8) elements: administration, social, infrastructure and utilities, transport, technology, human, economy, and environment. The first element is administration or governance. Washburn and Sindhu (2009) emphasise that city management is streamlined because, in today's service-based economy, an efficient city administration must provide efficient service and foster businesses for its residents. Besides, smart government service is also crucial because it can attract residents and effectively inform the city's conditions. Thus, a core component to reach this function and to manage city operation services such as healthcare, education, infrastructure, and efficient transportation is applying communication and collaboration technologies.

The second element is social standards to enhance education, increase access, improve quality of life, and reduce living costs. The increased access and engagement and improved quality and experience result from the extensive use of technology in education (Washburn & Sindhu, 2009). Moreover, Barrionuevo, Berrone, and Ricart (2012) reveal that to improve a city's social environment, there is a need for a variety of aspects, including extensive research, inclusive immigration policy, community development, elder and health care, and public health safety.

Next, utilities and infrastructure allow for waste, energy, and water usage reduction. However, infrastructure for efficient current systems contributes new options for producing and delivering water, gas, and electricity. According to Caragliu, Del Bo, and Nijkamp (2011), the use of networked infrastructure has a substantial impact on enhancing economic and political efficiency, which in turn facilitates social, cultural, and urban development that can be advantageous for business services, housing, leisure and lifestyle services, and ICTs. It suggests that the wired city is the primary development model and that connectivity is the source of growth.

The fourth element involves the use of technologies that facilitate domestic operations in government services. This encourages the continuity to transform important government agendas across departments, employees, citizens, and businesses, as advocated by a smart city (Nam and Pardo, 2011). The next element is human capital which is the key point to attract creativity, education, and social learning. A smart city must be a centre of public universities operating that excel in providing a skilled workforce. In addition, the main agenda is connecting communities, governments, businesses, and the general public, emphasising the need for a smart city to incorporate elements to enhance the

public's creativity, covering education, research, creativity, and talent (Barrionuevo et al., 2012).

The economic factor also encourages business development, economic expansion, and employment creation. According to Caragliu, Del Bo, and Nijkamp (2011), a business that focuses on urban development is vital for a smart city project. Moreover, businesses are one of the key factors in achieving socioeconomic performance in a smart city. The seventh element is the environment. Smart cities address environmental sustainability due to the ongoing depletion of natural resources and deteriorating environmental issues. Simultaneous efforts have been taken to solve pollution issues, manage the continuation of a clean and safe water supply, promote a green building agenda, and increase the use of renewable energy while reducing energy bills. According to Pellicer et al. (2013), a smart city must be able to offer its residents efficient energy use and effective resource management. Caragliu, Del Bo, and Nijkamp (2011) also state that environmental sustainability and social sustainability are important components of a smart city. With the decreasing resources, smart cities are expected to implement the usage of renewable energy.

Transportation is the eighth element. One of the goals of a smart city is to improve public transportation while reducing traffic congestion. Having fewer vehicles on the road reduces traffic congestion and environmental effects like the greenhouse effect and carbon concentration. Washburn and Sindhu (2009) explain that cities like London have successfully reduced traffic congestion in their metropolitan areas, by charging 30 per cent surcharge for entering the city.

The actual objectives, or the anticipated results, of smart city development are smart city performances. An ideal smart city can solve urban issues. Nonetheless, there are intriguing theories or viewpoints on this matter, resulting in varying viewpoints of previous research, such as in the research by Batagan (2011) and Mosannenadeh and Vettorato (2014). This is due to different problems faced in different successful smart cities. As a result, it is suggested that the issues affecting a city are regional and local-centric.

Figure 1 summarises the objective of developing a smart city is based on and includes improvements to the quality of life, economic competitiveness, and resource management. It also presents the other side is smart city performance.
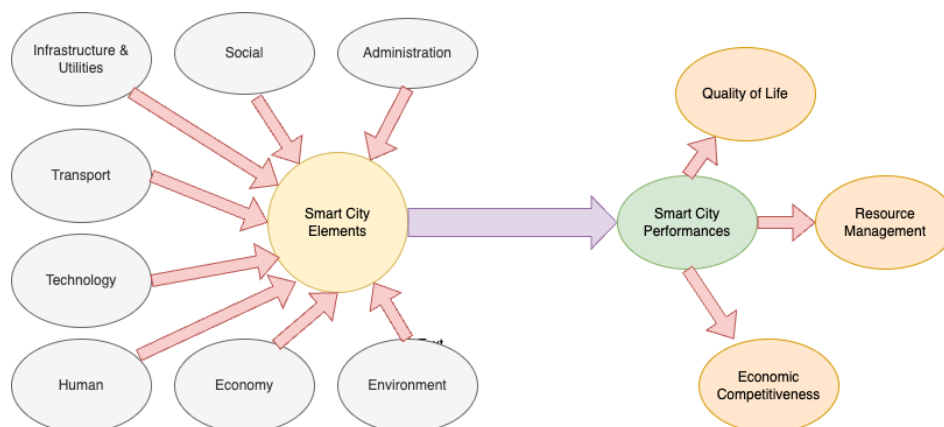
Figure 1: Smart City Conceptual Framework
Source: Author's Compilation

The term 'quality of life' in a smart city programme is interpreted as decreasing community stress levels, offering food infrastructure, increasing security, and increasing health levels. As for resource management, a smart city programme is believed to lower the greenhouse effect, manage waste, use renewable energy, enhance recycling programmes, pollution, optimal utilisation of resources, and many more. Last but not least, the performance of a successful smart city can be measured through economic competitiveness such as population growth rate, reduced unemployment rate, wage growth increase, and increased worker productivity.

Thus, this conceptual framework presents the performance and elements of a smart city. There are eight (8) elements which are administration, social, infrastructure and utilities, transportation, technology, human, economy, and environment. Accordingly, smart cities can be measured through the quality of life, resource management, and economic competitiveness.

RESEARCH METHODOLOGY

Onwuegbuzie (2012) emphasises that literature and critical analysis can be a tool for analysing and interpreting literature sources by taking into consideration both the scientific and grey literature that is currently available. Therefore, it is necessary to examine the current literature to determine any additional elements, performances, and sub-attributes that can be implemented into the body of knowledge to develop a more robust conceptual framework than that developed by Mosannenzadeh and Vettoroto (2014).

The current study selected three categories of the literature review's sources: academic, industrial, and governmental. The review focused on academic research papers, industrial papers, and government booklets from 2009

to 2021. The occurrences of the keywords 'smart city elements' and 'smart city performances' were tallied, and their frequency was calculated using an average.

This paper treated the smart city elements as a significant area of focus and smart city performances as challenges, following the study conducted by Mosannenzadeh and Vettoroto (2014). Therefore, this paper aimed to examine and analyse a literature review of the sub-attributes that enhance the conceptual framework developed by Mosannenzadeh and Vettoroto (2014) for smart city elements and performance.

DISCUSSION OF SUB-ATTRIBUTES FOR SMART CITY CONCEPTUAL FRAMEWORK

Table 1 shows the sub-attributes for the smart city elements and smart city performances. There was a total of 31 sub-attributes of smart city elements identified from 2009 to 2021. For smart city performances, a total of 11 sub-attributes were identified. All sub-attributes are shown in Table 1.

The administration consisted of four sub-attributes: e-governance, smart policy, implementation from an authority, and communication. Administration is important in ensuring all other elements are implemented properly and functioned. Therefore, the strength of authority, administration, or governance is required thoroughly (Chrisidu-Budnik & Przendanska, 2019). In addition, the social aspect is an element that supports smart city frameworks. Therefore, sub-attributes like community/individual intelligence, immigration policy, community development, elder healthcare, and public healthcare are important to ensure a mentally stable, peaceful, and harmonious community. In short, the growth of social society is interconnected with human development (Monfaredzadeh and Krueger, 2015). Figure 2 shows the interconnection between each element in the smart city framework.
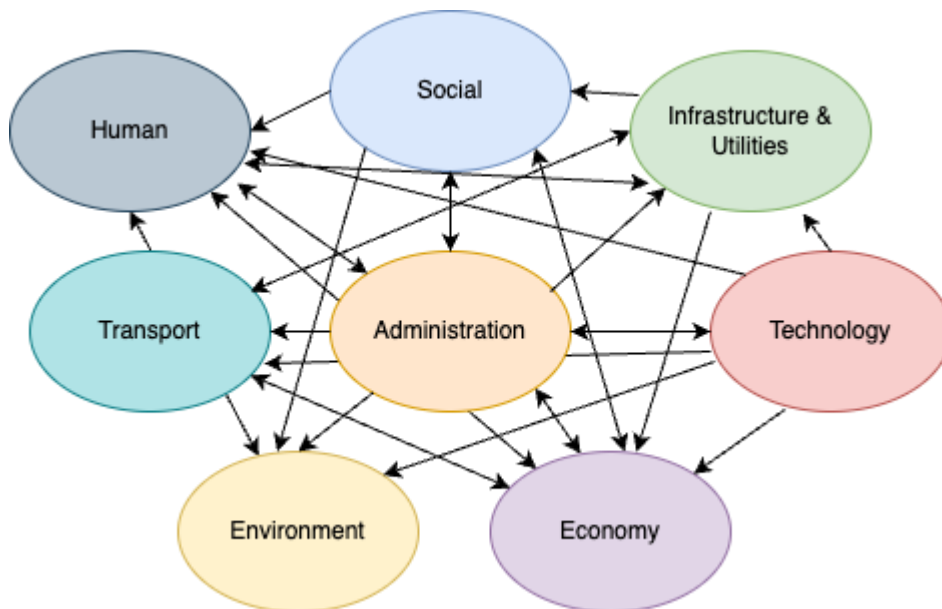
Figure 2: Interconnection between Smart City elements
Source: Author's Compilation

Human development, which comprises knowledge, skills, awareness of the surrounding society and environment, and good action, as well as modest behaviour, is part of the smart city framework. The support from each citizen contributes to the robustness of the smart city framework. Using skills, knowledge, and awareness, humans can create opportunities, enhance the economy, and utilise technology to the highest use, creating better infrastructure while taking care of the environment (Nam & Prado, 2011). Moreover, smart cities have a good economy, sustainable business, and higher chances of growth than other cities (Chorabi et al., 2012). This is because the development of technology has created a few types of economic opportunities and enhanced entrepreneurship, e-commerce, green investment, and the digital economy. In general, technology plays a vital role in the smart city framework. Technology improves daily life efficiency and promotes better transport, governance, economy, and infrastructure. For example, the Internet of Things (IoT), artificial intelligence (AI), and sensory and remote technology are current topics that can bring humans in a greater direction and perhaps a new opportunity that has never been discovered (Nam and Prado, 2011). 〔OBJ〕

Furthermore, Appreciating the environment that offers essential resources such as shelter, food, water, and other vital provisions (Chuorabi et al., 2012), the implementation of the smart city concept can produce an improved

environment as society and individuals actively address and mitigate pollution, adopt sustainable consumption practices, and enhance waste management. Hence, checks and balances are necessary for the various components that constitute the concept of a smart city.

The establishment of smart city performance can serve as a standard that citizens can utilise as a reference to assess the successful implementation, management, and utilisation of the smart city concept. Table 1 displays all the subordinate characteristics of this framework.

Table 1: Sub-Attributes for Smart City Conceptual Framework

Smart City Elements		
	Sub-attributes	**Author (year)**
Administration	E-governance	Lombardi et al. (2009)
	Smart Policy	Bokolo et al. (2018)
	Implementation	Chrisidu-Budnik & Przendanska (2019)
	Communicate	Washburn and Sindhu (2009)
Social	Intelligence	Zhang et al. (2017)
	Immigration policy	Barrionuevo et al. (2018)
	Community Development	Barrionuevo et al. (2018)
	Elder healthcare	Barrionuevo et al. (2018)
	Public health	Barrionuevo et al. (2018)
Infrastructure & Utilities	Networked Infrastructure	Caragliu et al. (2011)
	Connectivity	Caragliu et al. (2011)
Transport	Free congestion	Lawrence et al. (2006)
	Public Transport Efficiency	Frez et al. (2019)
Technology	IoT	Hassan et al. (2021)
	Sensory	Suakanto et al. (2013)
	Remote	Liang et al. (2020)
	Artificial Intelligence	Luckey (2020)
Human	Knowledgeable	Salin & Abidin (2011)
	Awareness	Bokolo et al. (2018)
	Skill able	Bokolo et al. (2018)
	Action	Kumar & Dahiya (2017)
	Behaviour	Kumar & Dahiya (2017)
Economy	Green Investment	Bokolo, Majid, Ramli (2018)
	Entrepreneurship	Kummitha (2019)
	Digital economy	Ivanenko et al. (2020)
	E-commerce	Mahizhnan (1999)
Environment	Sustainable consumption	Bokolo et al. (2018)
	Pollution free	Bokolo et al. (2018)
	Waste management	Bokolo et al. (2018)

Smart City Elements		
Smart City Performances		
Quality of life	Minimum Needs	Fang et al. (2021)
	Stress-free/High happiness index	Shwedeh et al. (2021)
	High-quality facility	Rahmawati et al. (2018)
	Low crime rate	Shapiro (2006)
	Community Engagement	Macke et al. (2018)
Resource Management	Pollution free	Samal et al. (2020)
	Responsive	Pereira et al. (2018)
	Transparency	David et al. (2015)
Economic competitiveness	Jobs creation	Sofrojenevic et al. (2014)
	High income	Hollands (2015)
	Innovation rate	Joshi et al. (2016)

Source: Author's compilation

CONCLUSION

The current study aimed to identify the sub-attributes of elements and performance of a smart city. A total of 42 sub-attributes that are crucial for establishing a high-quality smart city framework have been identified. These sub-attributes are instrumental in ensuring the success of smart cities. Nevertheless, it was necessary to assess the dependability and accuracy of these characteristics by performing a pilot study. Upon completing the pilot study, it is determined whether there are any additional attributes that should be incorporated into the smart city framework or eliminated through factor analysis and reliability testing.

According to Hollands (2015) and Thomas et al. (2016), citizens are often left out or neglected in the development of the smart city. However, Marrone (2018) emphasises that citizens are not entirely ignored, but rather they are not given the same level of recognition in the publication or work progress of the smart city as the developer and administration. Prior to that, Marrone (2018) contends that it is most advantageous to comprehend the viewpoint of the citizen, as they represent the practitioner-centric group that serves as the end-user and possesses a requirement that must be met before its provision. Not many researchers such as Lim et al (2020) who investigate the importance of participation of citizens in Smart Cities must be considered crucial. As a result, the current study believes that their opinions and suggestions play a vital role in developing the ideal smart city concept because they are the end-users of the proposed smart city model. Thus, the main recommendation of this research is to gain insight from citizens before developing a smart city project by outlining the essential elements and performance indicators required to meet the needs of

citizens in order to equip administrators and governors with a clear and efficient conceptual framework for smart city development.

ACKNOWLEDGEMENTS

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