PROPOSING A SMART SUSTAINABLE CITY FRAMEWORK: THE CONSTRUCTION PRACTITIONERS' PERSPECTIVE

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A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Quantity Surveying

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

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ABSTRACT

The exponential growth of population would threaten the availability of resources globally. In other words, some significant negative impacts such as urbanization and resource depletion might be an issue faced globally. Several researches had been carried out to tackle these major issues and it was discovered that smart city concept with sustainable features is the optimal solution to overcome the crisis confronted by all the cities. Several previous studies were conducted on defining and integrating the approaches of smart city. However, there is a lack of studies focusing on the smart city's elements and components, and how it achieves sustainability. On top of that, there are also limited studies on the awareness and component of smart sustainable city in Malaysia. Therefore, this research aims to identify the components of smart sustainable city and propose a smart sustainable city framework from the perspective of construction practitioners in Malaysia. Quantitative approach method was applied as the research method. The dimensions and components of smart sustainable city were identified through review of literature. There were five (5) dimensions, seven (7) components and seventeen (17) sub-components of smart sustainable city discovered. Questionnaire were designed and distributed to four hundred (400) construction practitioners consisted of architect, engineer, main contractor and quantity surveyor. A total set of 125 surveys were collected from the respondents. Cronbach’s Alpha Reliability Test was applied to determine the reliability of the data before proceeding to further data analysis. Then, arithmetic means was conducted on the data obtained related to dimensions, components and sub-components to determine the mean ranking. The findings reveal that the respondents are aware of the human factor in achieving smart sustainable city and smart data appeared to be the most important component followed by smart energy and smart building from the view of construction practitioners. Kruskal-Wallis Test was performed as the last data analysis method to reveal significant difference across the construction practitioners on the components of smart sustainable city. A smart sustainable city framework was proposed based on the data evaluated in this research. The findings in this research could be disseminated to the Malaysian Government, professional bodies and relevant parties to increase the level of awareness of

citizens towards smart sustainably city and accelerate the smart sustainable city implementation for future city.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this chapter, the study background, problem statement, research aim, research objectives, research methodology, research scope and chapter outline will describe the outline and overview of this research in detail.

1.2 Background of the Study

The rapid population growth that skyrocketed for the past two centuries will finally slowdown in the future (Roser, 2020). However, according to United Nations (2017), it was predicted that the world population will continue to grow and might reach the boundary of 9.8 billion by the year of 2050 regardless of the low fertility rates around the globe. The exponential increment of population will cause some major negative impacts such as rural to urban migration which is known as urbanisation and resource depletion since it could not cater the need of overpopulation.

United Nations (2018) once projected that 68 percent of the enormous world population will be shifting and lived in urban areas by year 2050. This would be a superior issue to the economic, politic and social in the future due to congested and overwhelming population in the city. In comparison between rural areas with urban areas, urban areas tend to have better access to electricity, more advanced technology, better quality of drinking water, more convenient in getting food, enhanced sanitation and medication and many more which make it a desirable place for living However, the overcrowded and congested urban area might create an issue of resource depletion. The scarce of resources are unable to satisfy the need of the overpopulation which subsequently cause a significant damage to the country. According to United Nation Environment Programme [UNEP] (2019), the exponential growth in extraction of resources and materials is the main culprit of biodiversity loss and climate change.

Thus, in order to counter all these major issues, several researches had been carried out. Experts from the aspect of economy, political and social proposed that implementing smart city concept is the optimal solution to overcome the crisis confronted by all the urban areas (Silva, Khan and Han, 2018). Höjer and Wangel (2015) indicated that smart sustainable city should be assisted by smart uses of

Information and Communication Technology (ICT) and concentrate on the needs of the citizens without bringing harm to future generations or other people. Moreover, Martinidis (2019), discovered that smart cities would be beneficial in enhancing the quality of citizen's life, increase efficiency of resources, reduce congestion and pollution, ensure security, accelerate economic development and many more. In a nutshell, a smart sustainable city is not only a city that possesses ICT technology but also implemented the technology in a manner that will bring positive impacts to the local citizens and community. In view of that, this study dedicates the research focus on smart sustainable city.

1.3 Problem Statement

Smart city is an urban area where ICT are applied in the field of municipal government and infrastructure to enhance various aspects, such as the economy, efficiency, environment and the quality of citizens' life (Wong et al, 2020). It was found that a few previous studies focused on investigating the use of ICT in smart sustainable cities. Lim, Kim and Maglio (2018) conducted a case study and found out that there are a few direct beneficiaries of big data uses in smart cities for local companies and government. Additionally, Mohanty (2016) declared that the smart energy system of smart city will help in conserving energy which also reduces the overall cost. Several researchers also agreed that smart cities have the advanced tools and technology such as sensors lighting, Artificial Intelligence (A.I.) to boost people's living conditions (Anisetti et al., 2018; Silva, Khan, & Han, 2018).

On the other hands, a few past studies examined the barriers that hindering the smart city development. Selvakanmani (2015) once published the problems and drawbacks of smart city. One of the main issues is that most of the smart technologies are still pre-mature and currently in the pre-commercial stage despite of the availability of money. The core item that the city lacks is the capacity and skills related to technology (Selvakanmani, 2015). Besides that, Odnorih and Lopushanskyi (2019) articulated that the adoption and implementation of smart city requires wide knowledge on various technologies in order to utilise the system. It is a huge challenge for other people to adapt to it without proper training and guidance. On the other hand, Glasmeier and Christopherson (2015) stated that the government, entrepreneurs and other relevant parties do not acknowledge the benefits and importance of the data that is generated and collected. The undervalue of data generated act as a barrier in implementation of smart city.

Based on previous smart city research, it is very clear that most of the research concentrated on and attempted to define the concept of smart city. Many attempts have been made to label a definition on the smart city concept, according to Mora and Deakin (2019), but they display a tendency to mark out one another, making it hard to obtain a common understanding of what smart city entails. For instance, Schaffers et al. (2012) described smart city as a future scenario based on technology and improving people's lives. Lazaroiu and Roscia (2012) have published that smart cities represent an interconnected, clean, enjoyable, attractive and stable society with average technology scale. Alkandari, Alnasheet and Alshekhly (2012) conducted a smart city survey and deduced that smart city utilizes an intelligent network made up by the interaction of resources, land, attitudes and cultures then accomplished by integration.

It is crucial to understand what and how the smart city works. Nevertheless, there are limited studies focused on the elements and components of smart city and how it achieves sustainability. Additionally, the are limited studies on the awareness and concept of smart sustainable city in Malaysia as well. Hence, a gap is identified as the awareness and understanding of smart sustainable city remains unclear in Malaysia. In order to pursue a better quality of life in terms of economy, environment or health, the smart sustainable city concept must be implemented in Malaysia. Thus, this research aims to fill up the gap by examining the awareness and identifying the concept of smart sustainable city.

1.4 Research Aim

This study seeks to explore the concept of smart sustainable cities for Malaysia by proposing a smart sustainable city framework (SSCF).

1.5 Research Objectives

Three research objectives have been identified to fulfil and attain the research aim:

(i) To determine the awareness of smart sustainable city concept in Malaysia.

(ii) To identify the components of smart sustainable city in Malaysia.

(iii) To propose a smart sustainable city framework for Malaysia.

1.6 Research Methodology

In the beginning of this research, the research problem is determined and studies are done on the related literatures and books. Then, a quantitative research method is chosen by distributing the questionnaire surveys. The data collected are analysed and tabulated by implementing three (3) statistical tests such as Arithmetic Means, Cronbach's Alpha Reliability Coefficient and Kruskal-Wallis test. Lastly, a SSCF is developed based on the findings.

1.7 Research Scope

In this research, the scope narrows to the practitioners in the construction industry to discover and explore the awareness of smart sustainable cities of construction industry related parties. The opinion and understanding of smart sustainable cities concept by the participants will pave a way of smart sustainable cities implementation in Malaysia.

1.8 Chapter Outline

There is a total of five chapters in this research. The first chapter which is introduction compromises the research background, problem statement, research aim, research objectives, research methodological approach, research scope, research chapter outline and the chapter summary. Then, chapter two presents the literature review which provides a deeper understanding of the concept of smart sustainable cities. The approach and benefits gain from smart sustainable cities will be briefly discussed as well. Most importantly, the theory and framework of a smart sustainable cities concept will be deduced and mapped.

After that, chapter three addresses the research methodological utilised to generate the data. This chapter also explain the method implemented to analyse all the data collected and result achieved. The final result and conclusion obtained from the questionnaire survey is deduced and tabulated in chapter four. In addition, the findings will be compared with previous studies as well. Lastly, chapter five draws a conclusion that represent the research after achieving the research objectives. The contribution of this research has been acknowledged for the body of knowledge and the industry. Not forgetting, the limitations faced and recommendations were proposed for future research.

1.9 Chapter Summary

To conclude this chapter, the disaster and crisis of resource scarcity must be resolved and prevented to ensure the life for future generation. To pave the way for this research the research aim and research goals were identified. In addition, the research methodological approach had been determined as well. The research scope was set to explore among construction practitioners. All the chapter’s outline was briefly explained as well.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will be explaining and exploring the definition and conceptualisation of smart sustainable cities. The characteristics and the framework of smart city will be elaborated in detail as well.

2.2 Smart Sustainable City

Smart sustainable city is a phenomenon or system that have been implemented by several cities around the world in order to tackle the issue of resource scarcity and overpopulation. Most importantly, smart sustainable city promises economic benefits, scale down environmental footprint and enhance a better lifestyle for the citizens.

2.2.1 Definition of a Smart Sustainable City

Back then, Albino, Berardi and Dangelico (2015) once said there are a lot of definitions of smart city, nevertheless the conceptual variants of it is still blurry. Fortunately, Mora, Bolici and Deakin (2017) did a smart city research that integrated the impression of importance of technologies within smart sustainable city and paved a clearer path on smart sustainable city definition. The smart sustainable city concept emerges only when smart city system and phenomenon has been introduced as the new solution to reinforce sustainability by combining the objectives of enhancing the quality of life, adopting Information and Communications Technology (ICT) in urban areas, focusing on sustainability of resources and enforcing new governance (Desdemoustier, Crutzen and Giffinger, 2019; Yigitcanlar et al., 2019).

According to Desdemoustier, Crutzen and Giffinger (2019), in order to strengthen the efficiency and effectiveness of the city, huge promotion has been done on ICT and technologies into city infrastructure. In short, smart city is like a fishing net, a broad network of data transmitting via sensors deployed throughout the city. From the data collected on a regular basis, a real-time view of things happening around the city will be mapped out. Then, the smart sustainable city will adapt, learn and modify the system based on the data collected in order to give more effective respond and enhance sustainability (Deakin, 2013).

2.2.2 Approaches of Smart Sustainable City

Smart sustainable city may sound something extremely complicated and hard to achieved, however Macke, Sarate and Moschen (2019) had done an investigation and broken down smart sustainable cities into three (3) criteria which are environmental well-being, material well-being and public services and facilities. From there, two mixed major approaches to obtain smart sustainable city can be carried out, which are the top-down method and the bottom-up technique (Breuer, Walravens and Ballon, 2014).

The top-down approaches are initiatives managed and set-up by city council to describe the sustainable perspective and act as a management platform because sustainability is a normative and socially developed term (Blewitt, 2018). For instance, the mayor of Barcelona, Jordi Hereu took a smart city top-down initiative and launched a public bicycle sharing schemes called Bicing in 2007 which helps in reducing carbon emission while promoting exercising (Winslow and Mont, 2019). On the other hand, bottom-up approaches are initiatives taken by citizens. As portrayed from a Colombian created association, Low Carbon City, it enables citizen to voice out what changes should be done in the town and the proposed changes regarding to the suggestions will be shared to citizens by the government (Johnson, 2014). This triggers a two-way communication between the government and citizens which aids in striving towards smart sustainable city while prioritising the people's needs.

2.2.3 Benefits of Smart Sustainable City

A lot of controversy had been going on when the idea of using technology, smart city to enhance and empower the nation's quality life while achieving sustainability first came out. Several researchers had questioned about the performance indicators and metrics that measure the efficacy of an ICT-driven technique to urban sustainability that development of smart city promises (Ahvenniemi et al., 2017; Klopp and Petretta, 2017; Marsal-Llacuna, Colomer-Llinàs and Meléndez-Frigola, 2015).

On the other hand, in the view of the European Union (2011), the smart sustainable city concept promotes the principle of environmental sustainability as its main goal is to minimize greenhouse gas emissions in urban environments by introducing new and advanced technologies. Birkeland (2014) also pointed out a smart sustainable city will help to build high-quality, renewable and regenerative urban environments around the circular economy with a positive effect on the natural environment. Additionally, technology can be very helpful when contemplating the protection and management of environmental infrastructure and capital, and natural resources with the overall aim of raising sustainability (Kramers et al, 2014). In a nutshell, a smart and sustainable city development is a must in order to counter and tackle the issue of urbanisation and resource depletion.

2.2.4 Dimension of Smart Sustainable City

The adoption and initiation of smart sustainable city requires a specific framework to recognise the target areas of innovation and opportunity that are essential to smart sustainable city projects. Sharifi (2019) distinguished that the frameworks can be categorised into 5 (five) key dimensions which compromises various relevant smart sustainable city development categories.

First of all, the crucial initial step is to establish and stabilise a sturdy technology aspect. Heaton and Parlikad (2019) highlighted that a smart city strongly depends on technology implementation. Specific combinations of technical technology interact to shape the array of smart city technologies with various levels of human-tech interaction (Joshi et al, 2016). In addition, Joshi et al (2016) specified that those key combinations that form the spectrum of smart city in terms of technology are intelligent, digital, ubiquitous, hybrid and wired.

Secondly, human dimension holds a major spot in building up a smart sustainable city. This is because the smart sustainable city has huge positive impacts on citizen’s quality of life. Furthermore, Glaeser and Berry (2006) strongly agree that human dimension plays a critical role as it is an essential indicator for the success of smart sustainable city. The human dimension supports and contributes creativity, knowledge and humanity.

Moving on, Lindskog (2004) mentioned institutional dimension must be present in order to promote smart sustainable city. A group was formed in accordance to foster the knowledge and idea of smart sustainable city which is known as Smart Communities since 1993. Smart Communities are citizens who share their passion and work in collaboration with government and other institutional organizations to encourage the use of information technology to improve the quality of everyday life (Lindskog, 2004).

Energy dimension and data management dimension are the next two key dimensions for smart sustainable city approaches (Sharifi, 2019). A smart sustainable city is mainly secured by smart connections between various areas such as smart buildings, smart environment, smart mobility and many more. The energy required for data transmission is supreme, thus the energy dimension must be established firmly beforehand. Lastly, Gharaibeh et al (2017) showed the importance of developing a data management system for smart city by declaring the data privacy and protection for the integrated data collection and processing.

2.3 Concept of Smart Sustainable City

First and foremost, the smart city concept was introduced around 1994 (Höjer and Wangel, 2014). Currently, more and more smart city projects start appearing since 2010 when achieved support from European Union (Jucevičius, Patašienė and Patašius, 2014). On the other hand, urban sustainability that is getting more popular focuses on environmental, economic and social (Berardi, 2013).

According to Ahvenniemi et al (2017), cities need to understand the biological, physical and social interactions that contributes to urban ecosystem. To achieve sustainability, recognizing the connections between people, their actions and the environment is essential. Lastly, Höjer and Wangel (2014) distinguished that a smart sustainable city is a revolutionary city that uses ICT to enhance the quality of life, the productivity of urban operations and services while ensuring that it protects the rights of current and future generations in economic, social, environmental, and cultural terms. From the review of previous studies, a total of seven (7) components such as Smart Governance, Smart Mobility, Smart Building, Smart Energy, Smart Logistic, Smart Data and Smart Education were found for the smart sustainable city.

2.3.1 Smart Governance

In accordance to the soaring of Industrial Revolution 4.0, Ruhlandt (2018) highlighted that the cities require smart administration and governance to efficiently handle the segments of the society. The governments can devise and enforce policies that are beneficial for society as a whole only through careful management of all the departments. Additionally, Lin (2018) published that smart governance as a core component of smart sustainable cities plays a role in empowering decision-making, policy strategies and perspective, public and social services and most importantly, providing a transparent governance.

Pereira et al. (2018) acknowledged and reported that smart governance aims at making the system more transparent by informing and updating the citizen. Public information will no longer be a source for a few elected officials or employees but will be open to all sectors of society. Besides that, Mutiara, Yuniarti and Pratama (2018) conducted a research on smart governance performance in Indonesia and pointed out that citizens are ought to be encouraged to share their opinions, thoughts about government services and schemes. In addition, Herdiyanti, Hapsari and Susanto (2019) deduced that the implementation of smart governance in Indonesia has increased citizen participation, strengthen democracy and public welfare.

By utilising the ICT in smart governance, the government carried out two major activities as the feature of smart governance. Firstly, electronic consultation (e-consultation) is the key feature that involves citizen participation (Lin, 2018). E-consultation serves as a channel of interaction between citizens and government. All the citizens' input will reach out directly to leaders, counsellors, town administrators or local heads. For example, a project portfolio that aims on energy saving was conducted in Amsterdam Smart City which is called as "Sustainable-Work, Living, Mobility, and Public Space" (Tomor et al., 2019). This project acts as a channel that composes smart collaboration between citizens, districts, enterprises and knowledge institutions to develop and trigger creative, innovative and sustainable solutions. From within, a societal interface lab project and solar platform project were introduced.

The second feature that the smart governance enhancement is electronic data (e-data). The main purpose of e-data is to provide and construct a transparent governance (Lin, 2018). E-data supports simple access to government assets, data on expenditure and investment and public information needs to be accessible online (Tomor et al., 2019). Data must be given freely and publicly, except for sensitive details relating to citizen's safety and security. In return, the government will be more accountable and citizen will be interested in the functioning of government. According to Mutiara, Yuniarti and Pratama (2018), transparency governance is a regulation acknowledgement in Indonesia as decisions and enforcements taken in a way that is compliant with rules and regulations, and it also means that information is publicly available, open to those impacted by these decisions and their enforcement. In addition, there have been an exponential growth in usage of social networking sites (SNS) and social media by government to communicate with the citizens regardless of Western or Eastern countries (Lin, 2018).

2.3.2 Smart Mobility

Due to the rising of urbanisation, the ever-increasing demand for transport is reflected in traffic congestion as well as higher energy usage and the related pollution. Based on the International Transport Forum (ITF) Transport Outlook 2017 (OECD and ITF, 2017), road transport is the largest contributor and responsible for about 75% of worldwide Carbon dioxide (CO_2) emissions. In addition to ITF Transport Outlook, the 75% CO_2 production is expected to be the primary contributor to global greenhouse gas (GHG) emissions by year 2050 (Zawieska and Pieriegud, 2018). In addition, Chin et al. (2017), found out that the average time spent for citizens in the Kuala Lumpur (KL) area is about twenty-five (25) minutes daily. Hence, it enhances the reason for smart mobility to be introduced in order to cope with the future impact on GHG emission by transportation and to solve the traffic congestion issue.

Joshi et al. (2017) pointed out that smart mobility is one of the significant ways in which smart cities boost citizens' everyday lives and enhance sustainability. Porru et al. (2020) reported that smart mobility is a triangle that affects economy, environment and society. The productivity of citizens is maximized, contributing to the boost of economy; energy consumption in the transport system is utilised efficiently which also benefits the environment; lastly citizens will receive benefits from the society which provides higher quality of life. Anastasiadou and Vouglas (2019) claimed that smart mobility includes information system and new transport technology.

Firstly, the information systems obtain data on traffic, vehicles and usage of different modes of transport. Such information systems can improve the accessibility and efficiency of public transport and also assist to optimize and regulate the use of private cars. Jeekel (2017) published that one of the greatest inventions on traffic is a system called Advanced Traffic Management System (ATMS). It is a legacy network that facilitates Smart Sustainable City implementation as it integrates all the knowledge from toll booths, traffic signals, car parks and infrastructure that contributes to smart mobility. Real time traffic data is obtained from video surveillance around the streets and then processed by Transportation Management Center (TMC) in order to deduce the actions required to increase the transportation system efficiency and enhance mobility. On top of that, Guo, Tang and Guo (2020) added that the real time traffic data obtained could elevate the parking spaces issue that exhausted most of the people's time and fuel circulating around looking for a parking space. As seen from the “Barcelona Digital City” plan introduced by the government of Barcelona, it was noted that wireless sensors were installed underneath the roads to guide drivers to vacant parking space through an application (Pedro and Aparicio, 2018). The application also provides function that allows the user to pay for the parking fees and generates parking data for other smart city systems.

Next, new transport technologies improve existing mobility modes or adding new ones. For example, a Smart Bike-Sharing Schemes (SBSS) was introduced (Zademach and Musch, 2018). This ground breaking model was built through a series of scientific and technical innovations and integrated implementations such as monitoring bicycle stations and travel routes based on global positioning systems (GPS), scanning quick response code (QR code) and using smartphone application software. In the measure of sustainability. Kou et al. (2020) analysed that the bike-sharing schemes encouraged 53% of citizens to hit on the bike rather than bus and rail. A total of 9,951.68 tons GHG emission was reduced in year 2016 from the calculation of reduced miles covered by vehicles and public transport usage (Kou et al., 2020).

Smart mobility had been implemented in various cities such as Singapore and India (Zawieska and Pieriegud, 2018). Singapore's smart transportation projects include automated driving trials, contactless fare payments, on-demand shuttle services and city transportation open analytics data. Inclusion of self-driving technology in vehicles in urban transit and freight addresses land and labour limitations. Moreover, commuters enter and leave fare gates via commuter-centred electronic payment systems for utilisation of public transport. Besides that, due to high congestion and accident rate in India, the government introduced smart mobility schemes to counter the issue. Joshi et al. (2017) stated that with safety at the forefront, India has set out to improve the protection of junctions with tools such as smart junction management and smart public transport systems. In addition, the system equipped with video surveillance and analytics up all time, entrusted with identifying traffic violations and sending real-time warnings about crimes or injuries to prevent accidents.

2.3.3 Smart Building

No matter which types of building, residential, schools, retails or hospitals, all of it requires at least 6 systems such as communication, energy, fire, lighting, security and access and heating, ventilation, and air conditioning (HVAC) to run as a building.

Buckman, Mayfield and Beck (2014) distinguished that all the buildings are inefficient due to high dependence on multiple systems that causes huge expense of energy, building usage and cost-effectiveness. Additionally, Esmaeilifar et al. (2015) pointed out that the construction industry in Malaysia has consumed approximately 35% of energy sources. Hence, smart building is initiated and aim to boost performance by integrating these systems to minimize running costs and to increase the security, productivity and quality of life of those employed and living within the four walls (Buckman, Mayfield and Beck, 2014).

Additionally, Shaikh et al. (2014) proposed that a smart building are using actuators, microchips and sensors to manage and analyse data according to a building's functions and services. This technology enables owners, operators and facility managers improve the efficiency and performance of assets, minimise the use of energy, maximise how space is used, and mitigate damage to the environment caused by buildings. In conclusion, Sjöström et al. (2011) deduced that smart buildings are collaborative, efficient, experiential, intelligent and secure. Hence, it creates a more living and healthier environment for the citizen and society.

Han and Zhang (2020) highlighted that smart building holds two major functions that promotes to smart sustainable city. First of all, predictive maintenance signals can be obtained through the data gathered from all the devices in the building system. The use of electronic controls would guarantee the smooth start and stop of all devices, predictive maintenance signal can be provoked if error occurs or there is a disturbance to the regular working pattern of the device. Maintenance and treatment of all machines or equipment may be carried out without hiring experts and halting all work. Moreover, Soyinka et al. (2016) added that the ability to perform repairs based on real hours used or known defects would produce significant savings. The economies of decreasing staff, prompt response and operating statistics are significant and fast as well.

Next, smart lighting control system plays a crucial role in achieving sustainability as the rapid emergence of skyscrapers in recent years calls for an upgrade in system in conjunction with the rise of Industrial Revolution 4.0. According to Firdaus and Mulyana (2018), smart lighting control system is an energy-efficient, convenient, and reliable lighting technology. It includes high efficiency fixtures and automatic controls which make adjustments based on conditions like occupancy or availability of daylight. There are a few types of smart lighting control system that had been implemented in houses, companies or even supermarkets and shopping malls. The use of sensors is the main contributor in smart lighting as most of the types rely on the sensors such as daylight sensing, occupancy sensing and motion detector. Daylighting sensing turns on or off the light when daylight is detected and not detected. On the other hand, occupancy sensing can be implied with motion detector as it is used to detect the presence of a person to control the lighting system of the room or building automatically.

2.3.4 Smart Energy

Energy reduction is a key to address current's most critical problems such as climate change, environmental conservation, food security, global energy, health and environment and sustainable growth. Unfortunately, traditional energy systems are unable to meet the multidimensional and multidisciplinary needs of the 21st century (Dincer and Acar, 2017). Over the years, emission of global GHG and climate change issues inflict severe impacts to the environment and citizen. Moreover, Rahim et al. (2017), carried out a research in determining the waste generated from construction industry in Malaysia and discovered that construction industry contributed 40% of waste and disposal. Nižetić et al. (2019) suggested for enhancement and implementation of sustainability in various countries in order to prevent the negative impacts.

By incorporating emerging technologies into urban management and service, smart sustainable cities deliver innovative solutions to the issues of economic, equity and sustainability development in urban areas by introducing smart energy (Calvillo, Sánchez-Miralles and Villar, 2016). According to Haarstad and Wathne (2019), a smart energy is a system or network capable of cost-effectively integrating the behaviour and activities of all users connected to it, including suppliers, manufacturers, distributors and customers, to ensure efficient, sustainable, low-loss, high-quality, reliable, safe and secure service delivery. Su (2020) indicated that industries can reduce the energy costs with smart utilities, shorten the carbon footprints and get more electricity from renewable sources.

First of all, the usage of fuel and carbon footprints could be reduced drastically by installing solar panels and smart meters. Solar panels which is renewable energy source could reduce the impacts on the environment by replacing the burning of fossil fuel in order to achieve sustainability. Furthermore, the carbon emissions of the appliances, tools, and equipment could be monitored by installing smart meters. Haning and Anda (2016) published that with the help of smart meter, the supplier and consumer would realise and understand the GHG that are being produced by the appliances. With the acknowledgement and realisation triggered, the consumer might shun away and stop using it or change to a lower carbon footprint appliance. Hence, this will directly decrease the demand of the product in the market and forces the supplier to reorganize their product into lower carbon footprints appliances in order to fulfil the demand (Wong et al., 2020).

Moreover, smart waste management is also a part of the smart energy that enhances the quality of life of citizen. Smart waste management utilizes sensors to monitor fill rates in waste receptacles and to alert city collection services when bins are ready to be emptied (Pardini et al., 2020). Over time, historical data collected by sensors can be used to identify the pattern of clearing the bins, improving driver routes and schedules and reducing operating costs. The cost of such sensors decreases slowly, making the installation of Internet of Things (IoT) waste bins more practical and more appealing to city leaders. In addition, the possibility of missed pickups and overflows would be eliminated thus enhancing the efficiency and reducing the carbon dioxide emission rate by collecting the waste on time.

Next, one of the most alarming issues that Malaysia faces every year is the issue of haze due to severe air pollution. Hence, smart air quality monitoring system is introduced to monitor and inform the citizens on the air quality index and measure the pollution level. Sung et al. (2019) pointed out that it is crucial to measure the cleanliness of the air as polluted air can bring deadly disease and harm to the human health. With the help of smart air quality monitoring systems, this helps keep the environment healthy and establish more efficient ways of combating pollution before the catastrophe occurs.

In conclusion, carbon dioxide emission can be reduced gradually with the help of smart energy in achieving sustainability. In India, the New Delhi smart city is the first ever city that run 100% renewable energy during the day as the city established over 50 hectares of solar park and countless of solar panels on the rooftops of 79 government buildings (Yenneti et. Al, 2019). Additionally, the city is reported to save about 13,000 tons of carbon emissions per year and power tariffs in the residential segment have been reduced by 10% last year and 15% this year due to low-cost solar energy (Yenneti et. Al, 2019).

2.3.5 Smart Data

Lackey (2019) once published that there are about two and half (2.5) quintillion bytes of new data being produced and created everyday with the growth of the Internet of Things (IoT) and the rise of Industrial Revolution 4.0. It was estimate that almost 90 percent of data was generated over the last two (2) years. Hence, smart data has been promoted to protect and secure the information of the data produced. According to Zeng (2017), smart data is digital information that is structured so that it can be used at the collection point before being submitted for further data aggregation and processing to a downstream analytics platform. Smart data is often correlated with the Internet of Things (IoT) and the data generated by intelligent sensors embedded in physical objects.

Besides, Hosseinpour, Plosila and Tenhunen (2016) agrees that the smart labelling is directly connected to the fact that a data entry point is intelligent enough to automatically make those types of decisions about incoming data, without needing centralized system processing power. Zeng (2017) stressed out that smart data is widely used in smart contracting. A smart contract is a computer program or transaction protocol designed to execute, control or record legally applicable events and actions automatically in compliance with the terms of a contract or agreement (Macrinici, Cartofeanu and Gao, 2018). The most crucial role of a smart contract holds can be found on Bitcoin, a cryptocurrency software. This is because all the confidential data such as contracts and agreements can be stored safely in secured network rather than paper documents.

Furthermore, smart data is quite popular in financial services such as monetary transactions as it stores all the transaction history and allow checking for anytime. In addition, the financial industries use smart data to build vast decision-making models through various statistical analyses and track specific purchasing trends (Hasan, Popp and Olah, 2020). The industries may therefore determine the financial products they should offer.

In a nutshell, smart data provides convenience and empower the quality of life of the people. This is because all the paperwork can finally be reduced and stored inside an infinite cloud storage and allows tracking easily and rapidly. The rising usage of cloud storage inflecting the decreasing utilisation of paper as well, thus promoting sustainability to the environment at the same time.

2.3.6 Smart Logistic

Courier companies are faced with greater challenges concerning lead times, protection and shipping costs. With the rising internationalization of the online shopping industry, shipping companies have had to develop their infrastructure to cope better with the growing demands for shipments (Frontoni et al., 2020). In addition, the greater volume shipments have filled higher-value goods with the means of transport. As a result, a higher level of security and privacy policy need to be enforced in order to prevent lost and damages to all the high cost products while maintaining efficiency. With the aid of Industry Revolution 4.0, the implementation of technologies which is also known as Logistic 4.0 or smart logistic can come into hand to cope with this logistic issue (Yavas and Ozkan-Ozan, 2020).

The smart logistic utilises autonomous applications and cyber-physical systems also known as robots and collaborative robots (cobots) in logistics (Gregor, Krajčovič and Więcek, 2017). The infusion of IoT, cloud data and advanced applications enhance and empower the digital supply chain (Protic, Geerlings and Duin, 2019). In another word, implementation of smart logistic will trigger and cope with the smart supply chain management as well. Sapio Research (2017) conducted a survey and deduced that there is a lack of end-to-end visibility of the supply chain and even the accessibility of information to make a decision is holding the manufacturers back from their goals. The result of the research showed that in today's highly competitive and demand-driven production era where agile process execution, end-to-end control and real-time data are among many priorities. Hence, there is a need to improve the visibility and cooperation of the supply chain, increase agility, alleviate risk, increase productivity and address to customer demands.

Secondly, the implementation and fusion of blockchain and IoT is a core component that will accelerate the whole smart logistic system that eventually enables the real-time tracking data of goods (Protic, Geerlings and Duin, 2019). Lumsden and Stefansson (2007) indicated that smart logistics must be taken place so that the work progress can be more efficient, effective and fast in order to tackle the real-time economy and fulfilling promises. In addition, Anderluh, Hemmelmayr and Nolz (2019) agreed that intelligent technology and cloud-based infrastructure help companies automate, optimize and re-adjust their supply chain. Real-time traffic data and complex route planning in practice reduce both transportation costs and carbon dioxide emissions. In conclusion, smart logistic provides faster flow of goods, real-time analysis, cost transparency, shipment tracking and enhance synchronization.

According to Blackman (2019), about 14% of China's Gross Domestic Product (GDP) is actually contributed by logistics department. Approximate of 40 billion packages, which is the half of the global total quantity were delivered from China. Hence, the logistics upgrades are a top economic priority for China. By implementing smart logistics into the system, a significant efficiency of 20% was deduced. The total Association of Southeast Asian Nations (ASEAN) trade with China shoot up to USD 1 trillion just by using smart logistics. China uses Artificial Intelligent (AI) to choose the best mode of transportation between water, air, road and rail thereby lowering costs and rising performance. The smart logistics is using real-time distribution monitoring and self-driving trucks in the ports.

2.3.7 Smart Education

In compliance with the rise of smart cities, the model of schooling and education will naturally follow its pace and evolve as well. The development of emerging technology helps learners to learn more efficiently, more easily, more flexibly and more safely (Zhu, Yu and Riezebos, 2016). Smart education is a concept that utilises digital for learning. Learners use smart devices to access digital resources through wireless network and immerse themselves in customized and seamless learning which eventually leads to the spark of smart education.

Smart university is one of the components of smart education. It is a place where technological innovations whereby the Internet are now able to deliver new standards of education. These smart institutions bear the tasks to train and educate the new specialist, competent and qualified enough to thrive in the Smart Society. The Smart University's intellectual base is a wide range of relevant science sources, information and instructional contents, and digital resources that can be easily and rapidly built, assembled to a specific package, uniquely tailored for each pupil, their needs and the peculiarity of their educational operation and the extent of educational achievements. There are five (5) key characteristics of Smart University mentioned by Morze and Glazunova (2013) to distinguish them from the others, which are: accessibility, mobility, openness, social orientation and technological effectiveness. Aside from its education system, the smart University should be well equipped with appropriate infrastructures and facilities to sustain Smart Education. For instance, multimedia center, multimedia classrooms, cloud infrastructure and scientific laboratories equipped with open virtual environments.

Moreover, smart learning also known as electronic-learning (e-learning) also plays a huge role in promoting smart education. Smart learning involves new educational ways in which the significance of using technologies at the student's fingertips is focussed (Morze and Glazunova, 2013). This depends not only on the software and hardware accessible, but also on how they are communicated in the classrooms or in combination with online learning. Smart learning is the future of higher education as it provides flexibility for all no matter for student or for adults. With smart education, all the knowledges can be found on the internet and hence it provides an opportunity for lifelong learning as all the knowledges are just one click away. Lifelong learning enhances the understanding to the matter surroundings and allows people to improve the quality of life.

In short, smart education is the key area that enables sharing of endless knowledges and offer chances for everyone to learn regardless of age, gender, physical abilities, religion and others. It helps to bind all the people together working and sharing ideas to create and generate more greater inventions.

2.4 Smart Sustainable City Conceptual Framework

Based on the exploration and deduction from previous studies, the dimension and component of smart sustainable city were determined. Hence, a smart sustainable city framework is proposed as shown in Figure 2.1. There are five (5) different dimensions that could contribute to the success of smart sustainable city which are the technology, human, institutional, energy and data management. Sharifi (2019) pointed out that all these dimensions must be focused and stressed on in order to share and spread the knowledge on smart sustainable city. Furthermore, the seven (7) components that were deduced from the literature review are Smart Governance, Smart Mobility, Smart Building, Smart Energy, Smart Logistic, Smart Data and Smart Education. Each of the component shall be taken into consideration during the implementation of smart sustainable city.

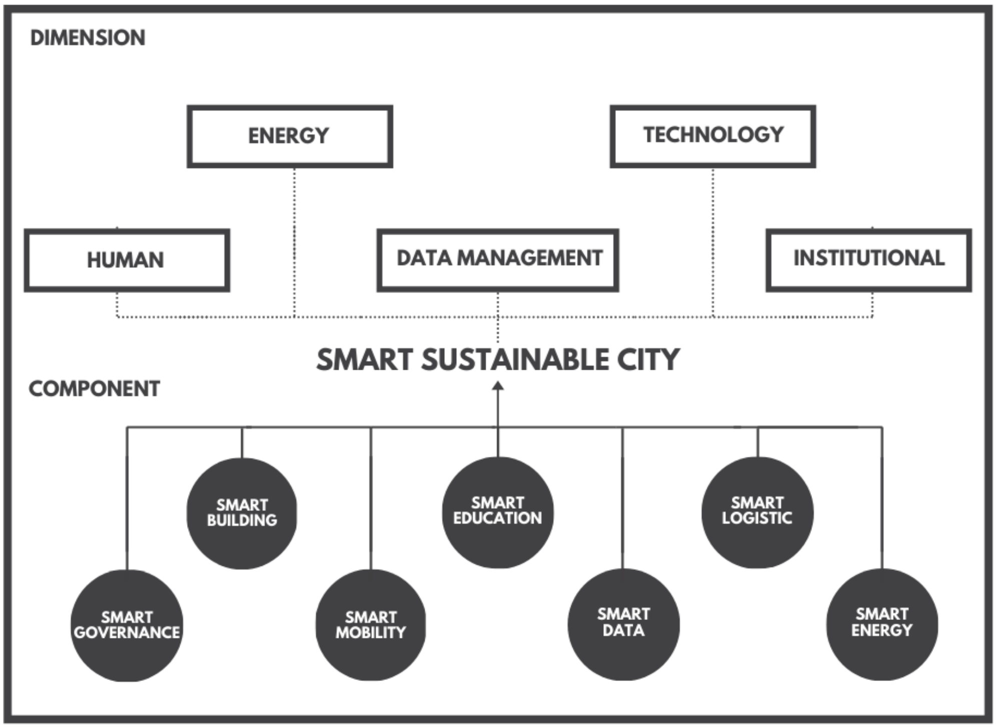

Figure 2.1: Proposed Smart Sustainable City Framework.

2.5 Chapter Summary

In conclusion, this chapter start off with the definition of smart sustainable city and ended with the proposed smart sustainable city framework made up from the five (5) dimensions and seven (7) components. Not to forget, the approaches of implementing and benefits of smart sustainable city were reviewed and studied in detail.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

In this chapter of research methodology, the specific techniques and procedures used to carry out this research will be discussed in detail. Besides, the throughout process of working out literature review are tabulated and the data collection method as well as determination of survey questionnaire. Lastly, discussion on survey sample encompassing technique used to analyse data will be explained also.

3.2 Research Method

Research has unlimited reach and it is often a cyclical phase with no clear route. Thus, a research method and design must be implied in order to tackle the research objectives and fulfil the research aim to draw a conclusion that make the research valid. Choosing the right method for research project will pave the route to success as methodology provide guidelines on managing the project (Langkos, 2014).

According to Creswell and Creswell (2018), there are three different approaches which are quantitative, qualitative and mixed research methods. All these three methods have their own consideration in carrying out data collection, analysis of data and data interpretation. Besides, the selection of a research method often depends on the complexity of the research question or topic to be discussed. In conclusion, research approaches, research design and research methods are therefore three major elements that reflect a research perspective that shows information from large research constructions to specific methods in a successive manner (Creswell and Creswell, 2018).

3.2.1 Quantitative Research Method

As shown in the term, quantitative research is much more about quantity which also means it is numbers driven. Besides, this research method is also known as a deductive approach method. This is because the research mainly emphasis on measuring variables via numerical data collection, analysing the data by tabulating into statistical models and identifying the relationships among the variables discussed (Creswell and Creswell, 2018; Lucas-Alfieri, 2015).

Creswell and Creswell (2018) once stated that quantitative research have assumptions about deductive testing of hypotheses, building on bias defence, checking for possible explanations and being able to repeat and generalise the results. Moving on, there are two key designs that build up this research method which are experiment research and survey research.

Survey research encompasses longitudinal and cross-sectional studies based on opinion surveys which is widely used. This is because a numeric deduction of attitudes, opinions and trends of a targeted population will be reported (Creswell and Creswell, 2018). For instance, the respondent will often be asked for their opinion in a series of structured questions and the responses will be tabulated therefore showing the generalised and major intent from the sample of a population.

On the other hand, experimental research which is not so commonly used compared to survey research because it is only carried out to identify a specific treatment affecting the result. The relationships are analysed by modifying factors that are assumed to affect the interest phenomenon while monitoring other variables important to the experimental results (Creswell and Creswell, 2018). Frankly, researchers may assess and conduct a research on the relationship between dietary intake and observable physiological changes such as weight loss, monitoring other main variables such as exercise (Creswell and Creswell, 2018).

One of the benefits of utilising quantitative research is that large sample size can be obtain in a short time (Rahman, 2017). For any hypothesis, a larger sample size is easier to draw an accurate and valid conclusion. The additional and real-time scenarios data obtained from this work brings greater legitimacy to the result as the statistical study needs to be checked in greater detail (Rahman, 2017). A larger sample makes it less likely that outliers in the study group will impact impartially on the results desired.

However, one of the limitations of this research method is that it does not take social phenomena into consideration. The quantitative approach aims to find answers to key questions to support or disapprove a specific hypothesis (Rahman, 2017). It doesn't matter what reasons people have when expressing an opinion or when deciding. The purpose of this phase of collecting information is to paint a real-time image of what is happening in the demographic selected (Rahman, 2017). That means that this choice cannot quantify how society shifts, or how people perceive their action or others' action.

3.2.2 Qualitative Research Method

On the other side of quantitative research, qualitative research focuses on scientific analytical approach to obtain non-numerical data. According to Creswell and Creswell (2018), qualitative research is an approach to evaluate and understand the significance of a social or human problem ascribed by individuals or groups. The study method includes developing questions and procedures, data collected at the participant 's premises, inductively analysing data from details to general topics, and finally interpreting the meaning of the data (Creswell and Creswell, 2018). Qualitative researchers use many different research methods, or study designs. The most widely used approaches to qualitative analysis include ethnography and grounded theory (Creswell and Creswell, 2018).

Creswell and Creswell (2018) indicated ethnography is also known as ethnographic research; it is the study of a specific culture and understanding of the role of a specific disease within its cultural context over a prolonged period of time. The data collection usually is in the form of interviews and observations (Creswell and Creswell, 2018). Next, grounded theory is based on observations or data from which it was created, it is an inductive form of research as it uses a variety of data sources, including quantitative data, record analysis, interviews, observations and surveys. Besides, Creswell and Creswell (2018) acknowledged that grounded theory is a form of sociological inquiry in which the researcher develops a general, abstract theory of a mechanism, behaviour or interaction based on the participants' views.

The pros of implementing qualitative research method is due to the ability to identify changing perceptions within a target community such as product or service customers or workplace perceptions (Opdenakker, 2006). Besides, if the answers obtained does not match the researcher's expectation that qualitative data is equally valuable to add meaning and maybe explain something that numbers alone cannot show (Rahman, 2017).

Despite that, the cons of qualitative research approach reflect on the sample bias and sizing issue. Rahman (2017) pointed out that bias on self-selection can occur when companies ask workers to volunteer their opinions. Regardless of online survey or focus group, the participants will tend to focus and bring forward themselves. On the side note, the researcher's bias in qualitative research would influence the results as well regardless of either conscious or subconscious. Opdenakker (2006) reported that the researched findings can be affected by bias. Controls is compulsory in part of the process of data collection to avoid researcher bias from affecting the findings.

3.3 Justification of Selection

The research method chosen in this research is quantitative research. The aim of selecting this research method is explore the concept of smart sustainable city among the citizen in a city. In order to achieve the aim, a large group of respondents are required as the research sample of population due to the reason of this is a study on the concept of smart sustainable city. By utilising survey research method, a huge amount of questionnaire can be distributed within a short period of time through softcopy and hardcopy. In corresponding, a large amount of data will be collected rapidly which also indicated that the information being researched can be analysed quicker compared to other methods of research.

After analysing the huge amount of data collected, an accurate and reliable result will be obtained from there. A consistent and generalised result will form from the group of population due to the same data points examined. In another word, the awareness of smart sustainable city concept among the citizen and the concept of smart sustainable city will be revealed from the result tabulated. Although there might be a slight variance among the result, the major repetitive data creates the fundamental certainty for the result. Hence, the result obtained will be the generalised answer of the population.

The core reason of not implementing qualitative research is due to the amount of respondent that could be reached out is very low. The process of carrying out interviews one by one among a large group of population requires a much longer time compared to quantitative research method. The timeframe required to carry out an actual interview would not be as short as answering a series of questionnaire. Hence, qualitative method is not suitable in this research.

3.4 Literature Review

A literature review is a study on knowledge and ideas established on a specific subject, including strengths and limitations, while at the same time discovering the academic opinion accepted on the topic and the differences on the same topic (Dawidowicz, 2010). Composing a literature review helps develop experience in effectively reviewing literature on a specific subject and increases the ability to recognize and interpret objective and relevant data on various subjects or fields of research (Booth, Papaioannou and Sutton. 2012).

The literature review is commonly used to identify the relationships between ideas and practice at the same time synthesising and gaining new perspective on the research during the process (Booth, Papaioannou and Sutton. 2012). According to Creswell ad Creswell (2018), there is no standard way to carry out the literature review, but many researchers are systematically collecting, analysing and summarizing the literature. First of all, identifying the topic that is manageable and completable within the specific time frame is the crucial step before rushing into a research project. At the same time, it is important to establish the research questions and arrange the literature around the subject areas of the questions into logical categories. The questions of the study must be precise enough to serve as a reference to the literature concerned. Last step before commencing on the research project, it is crucial to determine the key words and concept of the topic as it will ease the resource search later on.

After identifying the key words, the second step is to search for the most relevant sources regarding to the topic by using the key words. Creswell and Creswell (2018) suggested to locate books and journals that comprises the information that is connected to the research topic and duplicate as the central of the topic. Thirdly, a literature map would be formed from the compilation of useful literature (Creswell and Creswell, 2018). The visualisation of content into a bigger picture will illustrate the overall body and flow of the research. At the meantime, drafting of summaries from all the articles, journals and books found should be done while extracting into the literature map (Creswell and Creswell, 2018). All these summaries will be combined and included in the literature review of the research study. Lastly, reassembling and restructuring the literature review into an organized flow and centralising the important concepts (Creswell and Creswell, 2018). The literature review is to be ended with summary of the main concepts and themes.

In this research, the exploration of smart sustainable cities concept was chosen as the topic. There are a few keywords that determine the search direction of the research. First of all, smart cities concept is the crucial search area that provides the general idea and framework of what smart city is about. Moving on, the other keyword is smart sustainable cities. Sustainable is considered as the conservation and protection of the environment, uniform economic development and the enhancement and respect of human and social rights. Thus, all three (3) requirements were taken into consideration when exploring and reviewing the related journals and articles. At the same time of breaking down the component of smart sustainable city, there were some noticeable areas and studies such as the approaches, benefits and definition of smart sustainable city done by the other countries but there was limited studies done previously in Malaysia on the similar field. The literature review had discussed the dimensions and components of smart sustainable city.

3.5 Quantitative Data Collection

According to Ajayi (2017), there are primary and secondary sources of data when collecting data. The researcher gathers primary data first-hand for a particular purpose of study. The researcher could gather information through observation, survey, interview and many more (Ajayi, 2017). Then, the researcher may analyse the data using descriptive and inferential statistics when implementing quantitative research method. In contradiction with primary data, secondary data is collected indirectly which is through existing records regardless from internet or publications (Ajayi, 2017).

In order to accumulate a large amount of data, questionnaire method is the best technique to generate huge data within a short period of time. Kabir (2016) recommended that closed-ended surveys or online quizzes are the most suitable way to collect data in quantitative research method. Closed-ended surveys and online quizzes focused on questions that give the respondents predefined answers to choose (Kabir, 2016). There are two major types of closed-ended surveys which are categorical questions and ratio questions. Categorical survey questions are actually checkbox questions with answers of yes or no. On the other hand, ratio questions also known as matrix question which include a set of predefined values from which to choose on a fixed scale.

In this research, both primary and secondary data were collected as the resources of this research. The questionnaire is delivered mainly through email in order to fulfil four (4) different construction practitioners such as architect, engineer, main contractor and quantity surveyor. Additionally, the result gathered from each practitioner can represent as a real data since the time for the data collected is identical. Data collection using articles, books, e-book and e-journals which are the secondary form of data also utilised in this research. From the secondary data collected, concept enrichment and deeper understanding of the research topic has been gained throughout the process.

3.5.1 Questionnaire Design

In the mist of designing the questionnaire, a few areas were taken into consideration. First of all, the information that were required must be identified before starting the write up of questionnaire. Then, the content and order of the questionnaire plays a huge role as well. The reason behind this is because the content and order of presentation will act as a guide leading the respondent into the direction that was wanted. If the content and order of the questionnaire is messy and unorganized, the respondent would be confused about the aim and purpose of the questionnaire survey. Thirdly, the wording of the question could not be neglected as well. It is crucial to develop a well written format of question wording as it provides a simple way for the respondents to indicate their answer. The respondent no need to contemplate how to formulate the answer. Most importantly, the classification of responses will be easier and hence making the analysis very straightforward. Lastly, the length of the questionnaire was one of the concerns as well. A lengthy questionnaire will cause the respondent to get bored and distracted closer to the end of the survey and will not focus answering the question. What comes to worst is that the respondent might pause or stop at some point noticing that there are tons of questions left to be answered.

In this research, closed-ended survey is the method utilise to present the questionnaire. The distributed questionnaire consists of three sections which are Section A, Section B and Section C. In the first section, the respondents were requested to fill up all the demographic details regarding to the profession, years of working experience and so on. The awareness of smart sustainable city is measured in Section B based on five-point Likert scale ranges from strongly disagree to strongly agree. Whereas Section C ranks and measures the level of importance ranges from not important to very important for each smart sustainable city component in the view of construction practitioners. A sample of the questionnaire survey is attached at Appendix.

3.5.2 Sampling Determination

It is a crucial step in determining the sample of respondent for the research. This is because the whole population is too large and wide, there will be unlimited data and might take up a lot of resources in terms of time and cost. In corresponding to the issue, sampling determination is a must when conducting a research to limit and set a range for the research. Sarmah and Hazarika (2012) reported that probability sampling enables the obtaining of survey data that is representative of the study's target respondents. Since the data are obtained solely at random, this method of quantitative data collection rules out sampling bias.

In this research, Central Limit Theorem (CLT) was applied in order to determine and select the sampling size and range. Kwak and Kim (2017) published that CLT is the foundation and basic part of modern statistics and it is used to estimate the population parameters of a huge sample size selected randomly. On the other hand, Islam (2018) mentioned that statistically CLT can be applied in an adequately large sample size, the sampling distribution of mean for a variable must reflect a normal distribution, despite of the huge dispersal in the population. Brussolo (2018) stated that when the sampling size is very big and too wide, a pattern would occur and the mean and standard deviation of the sample distribution would actually represent the mean and standard deviation of the normal distribution, hence, it provide efficiency and effectiveness in estimating and drawing the characteristics of the population.

Taylor (2018) addressed that there are few criteria shall be achieved prior to the application of CLT in a research. The requirements stated that the it is crucial for the data to be collected are done randomly in a sufficiently huge population and the targeted sample size shall not be more than 10% of the population. Furthermore, the sample of the population should be genuine and independent to avoid the purity of data collected. Kwak and Kim (2017) concluded that a sample size of thirty (30) is adequate to reflect that the sample distribution is presented fairly normal when the population is symmetric. For this study, a sample size of thirty (30) is determined for each of the construction practitioners who are the architect, engineer, main contractor and quantity surveyor.

3.5.3 Questionnaire Distribution

There are various of questionnaire distribution method to collect data in a research. However, web-based questionnaire distribution method has been utilised in this research. Kabir (2016) indicated that self-completion surveys by phone, email or internet are typically the least costly, particularly for a wide-ranging sample. It allows some time for respondents to consider and record their responses without the feeling of stress and pressure. It also often removes the interviewer errors and the incidence of being unable to contact for selected individuals (Kabir 2016).

In this research, the web-based questionnaire was created via Google form and distributed through links, emails and messages. The questionnaire was sent to respondents among construction practitioners. The sole reason of implementing web-based questionnaire is because a huge range of population can be reach out within a short period of time. It is the fastest and most cost-effective method among all the distribution method. The respondent was only required to click on the survey link attached, then a secure website will be opened up automatically. Besides that, Kabir (2016) noticed that the primary benefit of a web-based questionnaire is the flexibility. The respondents are free to use either a desktop, laptop, tablet or smartphone to take the survey during their free time. This will enhance the quality of the answer and feedback received as no pressure and stress was forced on the respondent. Furthermore, a more straightforward statistical report can be seen and generated from Google Form after the respondent have finished answering.

3.6 Data Analysis

Data analysis is a process for cleaning, transforming, and modelling data to discover useful decision-making knowledge. It also aims at collecting valuable data information and making the decision based on the data analysis. According to Lutabingwa and Auriacombe (2007), techniques of data analysis concentrate on pragmatic approaches to raw data collection, searching for insights related to the primary objectives of the research, and digging down in this knowledge to turn metrics, facts and figures into strategies that gain change.

All the data collected were analysed by using a software known as Statistical Package for the Social Sciences (SPSS). Paura and Arhipova (2012) suggested that SPSS is one of the most common statistical packages which can use simple instructions to perform highly complex data manipulation and analysis. Besides that, SPSS can take data from virtually any file form and produce tabulated reports, maps, distribution and trend graphs, descriptive statistics, and complex statistical analyses (Paura and Arhipova, 2012). In this research, the suitable test applied are Cronbach’s Alpha (α) Reliability Coefficient, Arithmetic Means and Kruskal-Wallis test.

3.6.1 Cronbach's Alpha (α) Reliability Coefficient

Bonett (2014) published that Cronbach's alpha reliability is used to measure the reliability or internal consistency of data. In other word, it is used to determine how closely related a set of items as a group. Taber (2017) said that Cronbach's alpha is considered to be a measure of scale reliability or a coefficient of reliability and it is not a statistical test. Taber (2017) also added that a big value for alpha does not imply that the measure is unidimensional. The value of alpha in Cronbach will reflect on whether the result is excellent, good, acceptable, questionable, poor or unacceptable base on the rule of thumb for alpha score as shown in table 3.1 (Tavakol, 2017; Stephanie, 2014). It is demonstrated in Table 3.1 that the higher value of alpha score indicates the better internal consistency of the data.

Table 3. 1. Rule of Thumb for Alpha Score (Source: Stephanie, 2014)

Cronbach's Alpha	**Internal Consistency**
$\alpha \geq 0.9$	Excellent
$0.9 \geq \alpha \geq 0.8$	Good
$0.8 \geq \alpha \geq 0.7$	Acceptable
$0.7 \geq \alpha \geq 0.6$	Questionable
$0.6 \geq \alpha \geq 0.5$	Poor
$0.5 \geq \alpha$	Unacceptable

In this research, Cronbach's alpha is used to determine the reliability of data for Section B and Section C which is the awareness and importance of components of smart sustainable city. The Cronbach's alpha is calculated by comparing the score from each scale of Likert scale with the total score for each respondent. If the alpha score is above 0.7, it is deemed that the data from the Likert scale is reliable. The formula of Cronbach's alpha is deduced as follow:

$$\alpha = \frac{N \text{ x } \bar{c}}{\bar{v} + (N-1) \text{ x } \bar{c}}$$

Where,

$N = number\ of\ scale\ items$

$\bar{c} = average\ of\ all\ covariances\ between\ items$

$\bar{v} = average\ variance\ of\ each\ item$

3.6.2 Arithmetic Means

Enormous and bulk data is collected in each and every research, in order to break down the data meaningfully, it is crucial and essential to summarise it. The pile of data can be tabulated using tables of charts. However, the distribution of frequencies organises the heap of data into a few important categories (Cruz, 2008). In other word, the collected data can be interpreted as a single index or value to represent the data as a whole. This would not only summarise the data it is also very helpful in comparing the data. Arithmetic means is the most frequently used central tendency measure. According to Li, Gu and Zhao (2018), the central tendency is defined as the statistical measure identifying a single value as the representative of a whole distribution. It aims to give a precise description of all the data and a single value that could be the representative of the data collected.

. The implementation of arithmetic means in this research is to determine the means of the awareness and to rank the components of smart sustainable city accordingly. In other word, the mean generated from the data collected from Section B could represent the awareness of construction practitioners to smart sustainable city. On top of that, the ranking for each component could be arranged by deducing the mean of data in Section C of the questionnaire. The arithmetic mean is determined by summing all the meaning in the set of data and then dividing it by the total number of observations.

The formula given for arithmetic mean is:

$$\bar{x} = \frac{\sum x}{n}$$

Where,

$\bar{x} = mean\ of\ an\ item$

$\Sigma x =$ sum of an item

$n = total\ number\ of\ observations$

3.6.3 Kruskal-Wallis Test

Kruskal-Wallis is a nonparametric rank-based test that can be used to assess if there are statistically significant differences between two (2) or more classes of an independent variable on a continuous or ordinal dependent variable (Nahm, 2016). There are a few hypotheses that should be considered for implementing this test

(Vargha and Delaney, 1998). Firstly, the dependent variable shall be measured in ordinal whereas the independent variable should consist of two or more independent groups. Next, no relationship should be established between the observations of each group of variables.

In this research, Kruskal-Wallis test is used to analyse the data and evaluate according to the view of different construction practitioners towards the component of smart sustainable city. The reason of applying Kruskal-Wallis test in this research is that there are four (4) different independent variables from the construction practitioners such as architect, engineer, main contractor and quantity surveyor. In order to detect the significance differences between the construction practitioners, two hypotheses are formulated. The null hypotheses (H_0) will represent no significant difference between the groups while on the other hand, the alternative hypotheses (H_1) will reflect the significant difference between the groups.

Vaughan (2001) mentioned that the calculated H-value is used to determine the hypotheses by comparing the critical chi-square value. The null hypotheses (H_0) is failed to reject when the H-value is less than the critical chi-square. However, if the H-value is more than the critical chi-square, the alternative hypotheses (H_1) is then accepted. The critical chi-square value is depended on the value of alpha and the degree of freedom as shown in Table 3.2.

The formula used to calculate the H-value is shown as below:

$$H = \left[\frac{12}{n(n+1)} \sum_{j-1}^{c} \frac{T_j^2}{n_j}\right] - 3(n+1)$$

Where,

$n = sum\ of\ sample\ sizes\ for\ all\ samples$

$c = number\ of\ samples$

$T_j = sum\ of\ ranks\ in\ the\ j^{th}\ sample$

$n_j = size\ of\ the\ j^{th}\ sample$

Table 3.2: Chi-square table (Source: Vaughan, 2001)

Degree of Freedom	P-value			
	0.10	**0.05**	**0.025**	**0.01**
1	2.706	3.841	5.024	6.635
2	4.605	5.991	7.378	9.210
3	6.251	7.815	9.348	11.345
4	7.779	9.488	11.143	13.277
5	9.236	11.070	12.832	15.086
6	10.645	12.592	14.449	16.812

3.7 Conclusion

In conclusion, quantitative research method was implemented in this research in order to generate a huge amount of respond within a short period of time through the distribution of questionnaire. The data collected was analysed by using SPSS and further broken down with different data analysis method such as Arithmetic Means, Cronbach's Alpha (α) Reliability Coefficient and Kruskal-Wallis test. The results of the analysis will be deduced in the next chapter.

CHAPTER 4

RESULTS ND DISCUSSION

4.1 Introduction

In this chapter, the data collected and gathered from the questionnaire survey will be outlined and discussed in detail. This chapter begins by summing up the demographic details of the construction industry respondents. Next, all the collected data will be analysed using Cronbach's Alpha Reliability Test to identify and determine the reliability of the data obtained. Then, the arithmetic means of smart sustainable city (SSC) components are tabulated and ranked. Kruskal-Wallis Test is conducted as the last data analysis method to identify the significant difference of smart sustainable city components between the different groups of construction practitioners. Lastly, a conclusion is deduced to summarise the result of the study and represent the whole chapter.

4.2 Demographic of Respondents

A total of 400 sets of questionnaires have been distributed via email to the target respondents, who are construction practitioners such as architect, engineer, main contractor and quantity surveyor. The data collection period was set to be 5 weeks from 6th July 2020 to 3rd August 2020. However, there were only 125 sets of data completed and received within the stipulated period. Thus, it can be said that the rate of response for the survey was only 31.3%. All the data collected from the survey is tabulated as shown in Table 4.1.

Table 4.1: Demographic Detail of a Sample of 125 Construction Practitioners

Demographic Details	Frequency (n)	Percentage (%)
Age		
Less than 21 years old	-	-
21 – 30 years old	40	32.0
31 – 40 years old	40	32.0
41 – 50 years old	23	18.4
More than 50 years old	22	17.6

(Table 4.1 Continued)

Demographic Details	Frequency (n)	Percentage (%)
Profession		
Quantity Surveyor	33	26.4
Architect	32	25.6
Engineer	30	24.0
Main Contractor	30	24.0
Working Experience		
Less than 6 years	44	35.2
6 – 10 years	25	20.0
11 – 15 years	22	17.6
16 – 20 years	11	8.8
More than 20 years	23	18.4
Education Level		
Sijil Pelajaran Malaysia (SPM)	-	-
Sijil Tinggi Persekolahan	-	-
Malaysia (STPM)	21	16.8
Diploma	83	66.4
Bachelor’s Degree	21	16.8
Master’s Degree	-	-
Doctoral		
Current Smart Situation		
Strongly Disagree	35	28.0
Disagree	82	65.6
Neutral	8	6.4
Agree	-	-
Strongly Agree	-	-
Future Smart Situation		
Very Unlikely	-	-
Unlikely	1	8.0
Neutral	23	18.4
Likely	60	48.0
Very Likely	41	32.8

As shown in Table 4.1, the frequencies and percentages of construction practitioners characteristics are tabulated. Based on the Table 4.1 generated, there are eighty (80) respondents below forty (40) years old whereas the remaining forty-five (45) respondents are aged above forty (40) years old. Furthermore, it is shown that the number of data collected from four (4) different construction practitioners are almost identical which consists of thirty-two (32) responses from architect, thirty (30) responses from engineer, thirty (30) responses from main contractor and thirty-three (33) from quantity surveyor. Hence, according to Central Limit Theorem (CLT), the sample size of thirty (30) could represent the whole population. In other word, the data obtained from all the different construction practitioners could represent the opinion for the particular profession.

Moving on to the working experience, it is noticeable that majority of the respondents are having “less than 6 years” working experience and twenty-five (25) of the respondents had “6 – 10 years” of working experience. There is a total of fifty-six (56) respondents who have experience working in the construction industry for more than ten (10) years. The much-experienced construction practitioners group consist of twenty-two (22) respondents with “11 – 15 years” of experience followed by eleven (11) respondents with “16 – 20 years” of working experience and lastly twenty-three (23) of them had “more than 20 years” of experience in construction industry. In terms of, most of the respondents are graduated with a bachelor’s degree. On top of that, there are identical numbers of respondents who have diploma or master’s degree certificate.

Prior to Table 4.1, respondents were asked to scale the smart and sustainable situation of the current city condition in Malaysia based on their personal opinion. Majority of the respondents, 93.6% pointed out that the current city is not considered smart and sustainable whereas there are a few respondents, 6.4% who are neutral to the current circumstances. Subsequently, the respondents were requested to express their point of view on the probability of cities in Malaysia becoming smart and having sustainable features. Hundred and one (101) of the respondents agreed that the city in future will be smart and sustainable while only one (1) of the respondent feel that it is difficult for the city to become smart and sustainable.

4.3 Cronbach's Alpha Reliability Test

In order to determine the reliability of the data collected, Cronbach's Alpha reliability test is carried out. For this research, two (2) Cronbach's Alpha test are conducted due to different sections of data. The first test is used to identify the consistency and reliability of data obtained related to the respondents' understanding towards smart sustainable city. As shown in Table 4.2, the calculated Alpha score is 0.817 which is above the acceptable range of "0.70 – 0.79".

Table 4.2: Reliability Statistics of Smart Sustainable City Awareness

Cronbach's Alpha	**Cronbach's Alpha based on Standardised Items**	**N of items**
0.817	0.832	10

Moving on, the second test is applied on the data gathered for the seventeen (17) sub-components of smart sustainable city evaluated by the construction practitioners. Based on table 4.3, the generated value is 0.875 which is also higher than the acceptable range.

Table 4.3: Reliability Statistics of Smart Sustainable City Components

Cronbach's Alpha	**Cronbach's Alpha based on Standardised Items**	**N of items**
0.875	0.881	17

As published by Stephanie (2014), the reliability of the data collected is high when the value generated from Cronbach's Alpha test is high too. Hence, from the score calculated as shown in Table 4.2 and Table 4.3, a conclusion can be drawn that the data obtained is reliable to be used for analysis purpose.

4.4 Arithmetic Means of Smart Sustainable City

In this section, the awareness and components of smart sustainable city will be discussed and ranked based on the answered obtained from all the respondents. There are three (3) sub-sections which are mean ranking of smart sustainable city awareness, mean ranking of smart sustainable city main component and mean ranking of smart sustainable city sub-component. Each of the section will be breaking down and explaining on the data collected.

4.4.1 Mean Ranking of Smart Sustainable City Awareness

The understanding of respondents towards smart sustainable city was tested from ten (10) different statement in the survey. Respondents were asked to rank their level of agreement on the basis of the statement given concerning smart sustainable city. The ten (10) statement codes and descriptions are shown in Table 4.4.

Table 4.4: Codes and Description of Statement.

Group	Code	Description
Human	BA	
	BA1	SSC will enhance the quality of life of citizen.
	BA2	Humanity support such as knowledge economy enables success of building a capable SSC.
Technology	BB	
	BB1	SSC is powered by smart connections for various items in a city.
	BB2	SSC utilizes cognitive technologies such as Artificial Intelligence (A.I.) and Internet of Things (IoT).
Institutional	BC	
	BC1	Government support is the backbone of SSC
	BC2	development.
		SSC helps in elevating the economy of a country by
Data Management	BD	increasing efficiencies and effectiveness through
	BD1	technology.
	BD2	SSC is triggered by various creativity and innovation to improve development.
Energy	BE	SSC is a digital city that connects community and
	BE1	combines communications infrastructure.
	BE2	SSC is used to overcome the risk of resource scarcity in the future.
		SSC scales down environmental footprint.

In order to identify the awareness of respondents towards smart sustainable city, a mean test has been carried out on the main group of the dimensions of smart sustainable city. Table 4.5 depicts the mean ranking of the five (5) dimensions based on the data obtained from the respondents. Based on the Table 4.5, the respondents are aware that human factor is important in determining the success of smart sustainable city. However, the dimension that the respondent not aware of is the importance of institutional in enhancing and promoting smart sustainable city.

Table 4.5: Mean Ranking of Smart Sustainable City Dimensions

Code	**Dimensions**	**Mean**	**Rank**
BA	Human	3.89	1
BD	Data Management	3.43	2
BB	Technology	3.40	3
BE	Energy	3.35	4
BC	Institutional	3.28	5

A mean test has been conducted to determine the overall awareness of the respondents from the data set. Table 4.6 shows the mean ranking of respondents' awareness towards smart sustainable city. The table was tabulated with the overall average score from all construction practitioners and the score from architect, engineer, main contractor and quantity surveyor separately.

Table 4.6: Mean Ranking of Smart Sustainable Awareness

Code	Overall		Architect		Engineer		Main Contractor		Quantity Surveyor	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
BA2	**3.92**	**1**	**3.84**	**3**	**3.93**	**1**	**3.97**	**1**	**3.94**	**2**
BA1	**3.86**	**2**	**4.03**	**1**	**3.83**	**2**	**3.50**	**2**	**4.06**	**1**
BD1	**3.54**	**3**	**3.88**	**2**	3.33	5	**3.33**	**3**	3.58	5
BE1	3.48	4	3.63	4	**3.60**	**3**	3.17	8	3.52	8
BC2	3.46	5	3.50	5	3.30	6	3.30	5	3.70	4
BB2	3.45	6	3.47	6	3.23	8	3.33	3	**3.73**	**3**
BB1	3.35	7	3.44	7	3.27	7	3.13	9	3.55	7
BD2	3.32	8	3.31	8	3.13	9	3.23	6	3.58	6
BE2	3.21	9	3.31	9	3.37	4	*2.80*	*10*	3.33	9
BC1	*3.10*	*10*	*2.91*	*10*	*3.10*	*10*	3.23	7	*3.15*	*10*

Note: **Bold** indicates the top three ranking, *italic* indicates the lowest rank

From Table 4.6, the overall top three (3) statement with the highest mean score are **BA2** = "Humanity support such as knowledge economy enables success of building a capable SSC", **BA1** = "SSC will enhance the quality of life of citizen" and **BD1** = "SSC is triggered by various creativity and innovation to improve development" with mean value of 3.92, 3.86 and 3.54. However, the statement with the lowest mean value, 3.10 is **BC1** = "Government support is the backbone of SSC development". It is clear that most of the construction practitioners agreed that **BA2** is the most important element of establishing smart sustainable city in Malaysia as it appears as the top one for engineer and main contractor perspective, top two from the quantity surveyor opinion and top three from the view of architect. With only a minimal difference of 0.06, **BA1** deemed to be as important as **BA2**. This is because **BA1** ranked first for both architect and quantity surveyor while came in second for engineer and main contractor.

By referring to the Table 4.6, it is clear that most of the respondents agreed that **BA2** which is the human support factor plays a huge role in determining the success of smart sustainable city implementation. Human factor is the actual gist of drawing value from the data and ensuring the success of implementation of smart sustainable city (Glaeser and Berry, 2006; Oliveira and Campolargo, 2015). Data is the fuel of running smart sustainable city. There will be tons of data exchanges and connections going on such as the sensor system sending empty parking slot signals to the citizen that are looking for parking spaces. Hence, all the data collected should be handled in the correct manner in order to enhance the smoothness of the smart sustainable city system. Oliveira and Campolargo (2015) said that it is essential to empower and motivate people to make sense and understand the functions of the data so that they can become the knowledgeable leaders in the communities and achieve positive changes for the citizens. Winslow and Mont (2019) investigated the public bicycle sharing schemes introduced by the mayor of Barcelona and found out the importance of data-driven insights that lead to a change in population health, transportation patterns and spatial equity. The reason behind the importance of human support is that not only contribution from knowledgeable developers assisted in the innovation and improvement of technologies, the citizens act as the main drivers of change as well (Glaeser and Berry, 2006). This is because the citizens and communities play a crucial part in the innovation of smart sustainable city by interacting with the public authorities and developers. Citizens could ensure and address the challenges faced in the city through the collaborative interaction with the authorities. Thus, the implementation of smart sustainable city will be focusing on addressing the city challenges as priority in order to enhance the quality of life of the citizens, which is the second highest mean score based on Table 4.6.

BA1 stated that the smart sustainable city will enhance the quality of life of the citizens and most of the respondent agreed to it. Several researchers had doubt on the performance of smart sustainable city in providing better quality of life for the citizens. This is because the complexity of the advanced technology is believed to worsen the quality of the current lifestyle (Klopp and Petretta, 2017). However, majority of the researchers had found out that the implementation of smart sustainable city can improve the quality of life for the citizens (Birkeland, 2014; Rama et al., 2017; Burguete et al., 2018; Woetzel et al., 2018). The implementation of smart sustainable city will not only help in cost savings but also boost up the efficiency and effectiveness of productivity (Rama et al., 2017). Burgutete et al. (2018) published that if the smart sustainable city is implemented strategically, all the smart technologies will have an immeasurable impact on the qualitative factors. Woetzel et al. (2018) reported that the application of smart technologies would empower the public safety by reducing the probability of urban fatalities. On top of that, by utilising a variety of smart applications the greenhouse gas (GHG) emission would be reduced by at least twenty-five (25) percentage, which helps to achieve sustainability in the city.

The third statement that the respondents agreed to in overall is **BD1** which is the development of smart sustainable city is initiated by the various innovation and creativity. Alba, Haberleithner and Lopez (2017) published that smart cities is known as the digital innovation such as advanced technology, autonomous devices and sensors brought to cities. Heaton and Parlikad (2019) highlighted that the implementation of technology is crucial in adopting smart sustainable city and the origin of the advanced technology is from the creativity and innovation of knowledgeable parties and developers. Roblek (2019) deduced that the communication system carried out in Vienna is the ideal example as it encourages the citizen to participate in the implementation process. As a result, Vienna utilises open innovation and co-creation to involve several stakeholders in the development of new project concepts. In addition, Tomor et al. (2019) reported that the success of smart sustainable city implementation in Amsterdam is due to a key channel of intellectual collaboration between citizens, districts, developer and institutions of knowledge to build and ignite the creative, innovation and sustainable solution.

Referring to Table 4.6, the lowest mean score is 3.10 which is the statement of **BC1** that states the government is the backbone of the success of smart sustainable city. Minority of the respondents agreed that the participation of government is essential in implementing smart sustainable city. However, Ruhlandt (2018) stressed that a smart city must require good and intelligent administration and governance. The reason behind it is that the government has the capability to address the priorities of the smart sustainable city while setting the challenges faced by the citizens as the primary issue. Gohari et al. (2020) recognised the ‘governance’ as the most significant aspect for smart city development. The government should be accountable to the citizens as the only institution with a public mandate and shall encourage the national interest and public goods to the citizens. The citizens need the government to run and manage the country effectively, vice versa, the government requires the knowledge from the citizens to cooperate efficiency as well. The government could also help in the research and development of technology in the country by sponsoring and bringing in more advanced technology. The reason why the respondents did not rank this approach as an important initiative might be due to less awareness on the role of government in implementing smart sustainable city.

4.4.2 Mean Ranking of Smart Sustainable City Main Component

Table 4.7 shows the overall mean ranking for all seven (7) main components for smart sustainable city. The highest mean score would represent the most important component in the view of construction practitioners.

Table 4.7: Mean Ranking of Smart Sustainable City Main Component

Code	Main Component	Mean	Rank
CF	**Smart Data**	**4.45**	**1**
CD	**Smart Energy**	**4.41**	**2**
CC	Smart Building	4.36	3
CB	Smart Mobility	4.35	4
CA	Smart Governance	4.27	5
CE	Smart Logistic	4.16	6
CG	*Smart Education*	*3.79*	*7*

Note: **Bold** indicates top two ranking, *italic* indicates the lowest mean ranking.

As shown in Table 4.7, the highest ranking is the **CF =** "smart data" followed by **CD** = "smart energy" with a close mean score of 4.45 and 4.41 respectively. On the other hand, **CG =** "smart education" came in last with the mean score of 3.79 only. From the view of construction practitioners, **CF**, smart data could resolve and alleviate the work productivity in a construction firm. The reason behind this is that there are too many data required to be stored for each construction practitioners regardless of the profession. Imagine a single project would needs few sets of drawings, contractual documents and prove of orders or instructions required to be stored, then there are twenty (20) new projects for the company annually. Not to forget that each construction project might take up to at least two (2) years. In other words, all the documents must be organised and stored properly for a period of twenty-four (24) months. At the best case scenario that the documents can be found successfully without wasting any time, it is hard to guarantee the form of the documents are still in the best state, for instance, the colour of the wording might had faded away, some of the pages of the document had been torn and the paper might have become brittle and turned yellowish. Hence, **CF**, smart data could be the rescue to tackle with all these issues faced by all construction practitioners. Zeng (2017) stated smart data would empower the productivity of construction industry with the help of smart contracting, cloud computing and monetary transaction services. Smart contracting allows the execution and record of legally events and actions such as an agreement with the terms of contract (Macrinici, Cartofeanu and Gao, 2018).

Next, **CD**, smart energy ended up as second with a close difference of 0.04 with smart data only. The close difference indicated that smart energy is an essential component for smart sustainable city as well from the perspective of construction industry. The construction industry is known for causing impacts on the environmental such as air pollution, water pollution, waste pollution and most importantly the sole contributor to climate change. Thus, smart energy is highly important to the construction industry to address the pollution matter in order to achieve sustainability. Haning and Anda (2016) suggested that all the usage of fuel and carbon footprints could be reduced by replacing it with solar panels and smart meter. Solar panel helps to generate electricity to be used in the office or even at the site since the exposure of sunlight to the site is a lot. Moving on, smart meter is utilised to measure the amount of GHG being produced by the machines and appliances. When the GHG amount produced is identified, the supplier and consumer would only realise the impact that had been done to the environment and hence the appliances or machines that has high GHG production would be rejected.

On the other hand, **CG**, smart education scored the lowest among all the components with a mean score of 3.79. Smart education might not appear to be as important to the other components in the table because most of the respondents had started working and did not get to experience the perks and benefits provided from smart education. However, the mean score of 3.79 indicates that the level of importance is on the high side of average since the score is only 0.21 away from 4.00.

4.4.3 Mean Ranking of Smart Sustainable City Sub-Component

There are seventeen (17) sub-components grouped under seven (7) different components such as smart governance, smart mobility, smart building, smart energy, smart logistics, smart data and smart education. Table 4.8 depicts the codes and descriptions of the seven (17) sub-components.

Table 4.8: Code and Description of Smart Sustainable City Sub-Component

Group	**Code**	**Description**
Smart Governance	CA1	Government's data such as incomes and expenses can be viewed publicly by citizen.
	CA2	Citizen can provide ideas and voice out opinions freely to the government.
Smart Mobility	CB1	Car-pooling or bike sharing can be done through applications or by Quick Response code scanning.
	CB2	Video surveillance cameras provide real time traffic data to prevent and solve traffic situation such as congested roads and accidents.
	CB3	Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application.
Smart Building	CC1	Data obtained from sensors in a building can help to generate and deduce a predictive maintenance.
	CC2	Lighting control system of a house/building can be done through application to reduce energy consumptions.
Smart Energy	CD1	Installation of solar panels on the roof can generate electricity replacing burning of fuel resources.
	CD2	Greenhouse effect can be prevented by measuring and monitoring the carbon footprint produced.
	CD3	Garbage and disposal will be automatically collected when the bin is full by having sensors sending data to the management.
	CD4	Air quality can be monitored and controlled by measuring the pollution level with sensors on top of the building or around the streets.
Smart Logistics	CE1	Use of autonomous machines such as robot and machines in supply chain management.
	CE2	Real time tracking data of goods during shipment to ensure safety and security of the product to the consumer.
Smart Data	CF1	Confidential data such as contracts and agreements can be stored safely in a secured network rather than paper documents.
	CF2	Paying fees or conducting monetary transaction through online anytime and anywhere.
Smart Education	CG1	Implement electronic learning (e-learning) enables classes to be carried out through online and remotely which will replace face-to-face learning.

Table 4.8 (Continued)

Group	Code	Description
Smart Education	CG2	Lifelong learning can be achieved easily by browsing through the internet as vast amount data are available.

A mean test was performed on the seventeen (17) sub-components smart sustainable city based on the recognition of four (4) separate groups of construction professionals. Table 4.9 indicates that the mean score for all seventeen (17) sub-components rated and ranked by architect, engineer, main contractor and quantity surveyor. The table portrayed the ranking of each sub-component. The table was tabulated with the average score of the overall construction practitioners and the score from each of the professions separately.

Table 4.9: Mean Ranking of Smart Sustainable City Sub-Component

Code	**Overall**		**Architect**		**Engineer**		**Main Contractor**		**Quantity Surveyor**	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
CB3	**4.77**	**1**	**4.78**	**1**	**4.86**	**1**	**4.87**	**1**	**4.56**	**3**
CC2	**4.70**	**2**	**4.72**	**2**	**4.80**	**2**	**4.73**	**2**	**4.58**	**2**
CD3	**4.68**	**3**	**4.69**	**3**	4.70	4	**4.67**	**3**	**4.67**	**1**
CD1	4.61	4	4.56	5	**4.77**	**3**	**4.67**	**3**	4.45	5
CF1	4.51	5	4.59	4	4.63	5	4.57	5	4.27	10
CB2	4.47	6	4.53	6	4.33	7	4.57	5	4.45	5
CA2	4.42	7	4.44	7	4.27	9	4.47	7	4.48	4
CF2	4.38	8	4.34	8	4.37	6	4.43	8	4.39	7
CD4	4.23	9	4.22	9	4.23	10	4.17	9	4.30	9
CE2	4.22	10	4.19	11	4.27	8	4.07	13	4.33	8
CA1	4.11	11	4.22	10	4.10	14	4.10	12	4.03	13
CD2	4.10	12	4.06	13	4.13	13	4.10	11	4.09	12
CG2	4.09	13	4.19	12	4.10	15	4.13	10	3.94	15
CE1	4.09	13	4.03	14	4.17	11	4.00	15	4.15	11
CC1	4.01	15	3.88	15	4.13	12	4.07	14	3.97	14
CB1	3.82	16	*3.66*	*16*	3.90	16	3.93	16	3.82	16
CG1	*3.48*	*17*	*3.66*	*16*	*3.43*	*17*	*3.37*	*17*	*3.45*	*17*

Note: **Bold** indicates the top three ranking, *italic* indicates the lowest ranking.

Based on the Table 4.9, an overall result shown combining all the point of views of the construction practitioners. The top three (3) sub-components with the highest mean score are **CB3** = "Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application" followed by **CC2** = "Lighting control system of a house/building can be done through application to reduce energy consumptions" and finally **CD3** = "Garbage and disposal will be automatically collected when the bin is full by having sensors sending data to the management." with the mean score of 4.77, 4.70 and 4.68 respectively. According to the Table 4.9, the top three (3) sub-components from all the construction practitioners are almost identical. Architect, main contractor and quantity surveyor have the same top three (3) sub-component ranking as the overall score. Nevertheless, **CD3** ranked as the fourth for engineer. On the other hand, the lowest mean ranking for overall score and four (4) of the construction practitioners is **CG1** = "Implement electronic learning (e-learning) enables classes to be carried out through online and remotely which will replace face-to-face learning" with the mean score of 3.48.

CB3 indicated the information for empty parking slot and quickest route to reach the destination deemed to be the most agreed important sub-component for smart sustainable city. It is undeniable that traffic jams happen very often in the city area and it had become a part of the city culture. Boston Consulting Group (BCG) conducted a study on the average time spent daily looking for parking spaces around Kuala Lumpur (KL), the result from the study exposed that the citizens in KL at least took up to twenty-five (25) minutes driving around in circles just to find an empty spot (Chin et al., 2017). By spending twenty-five (25) minutes daily, it would accumulate up to at least six (6) days' worth of time in a year. On top of that, spending extra twenty-five (25) minutes could cause delays that may result in late arrival for meetings, tender bidding, tender submission and the worst scenario is losing a new project from the perspective of construction industry. Thus, most of the respondents chosen **CB3** as the most crucial sub-component of smart sustainable city. In addition, Guo, Tang and Guo (2020) pointed out that the real-time traffic information collected could elevate the problem of parking spaces that wasted much of the people's time and fuel going around in search of parking. On top of that, Pedro and Aparicio (2018) reported that the installation of wireless sensors underneath the roads in Barcelona smart city would lead and guide the drivers through an application to vacant parking spaces. In a long run, the efficiency and productivity of the citizen will be enhanced and empowered due to lesser time wasted. Hence, this sub-component would not only bring positive impact to the construction industry.it would affect all the citizens in the city as well.

The second highest ranked sub-component is **CC2** which addressed the lighting control system over an application. Esmaeilifar et al. (2015) conducted a study on the electricity consumption of construction sites in Malaysia and deduced that the construction plays a major part of the energy consumed in Malaysia as it accounts for approximately 35%. The main consequence of utilising too much energy would cause an increase in carbon footprint. This harmful effects kicks in when generating electricity. The more electricity generated, the more carbon dioxide (CO_2) will also be emitted and without any proper way of dealing the CO_2, it will remain in the air and induces global warming. Most of the respondents agreed on the importance of addressing the lightning control system in tackling the global issue and achieving sustainability for the city. Smart lighting control system is an energy efficient, comfortable, and reliable lighting technology according to Firdaus and Mulyana (2018). It includes high performance attachments and automated controls that allow changes based on factors such as occupancy or daylight availability. There a wide range of smart lightning control system that could be applied. The application of sensors is the major contributor to smart lighting as most of systems rely on sensing structure. Daylight sensing could be applied on the construction site as the lights turn on or off by detecting the sun light. Additionally, motion detector could address the major issue of forgetting to turn off the lights before leaving the site as it is used to automatically detect a person's presence at the certain area. For instance, if the workers are still working late at night, the light will be turned on by itself. This would also signal the people around the site to be alert on the surrounding as the construction work is ongoing. Conversely, when all the workers leave the site, the light would be turned off. Thereby, the electricity usage from the construction industry or the construction site could be lessened and reduced.

Subsequently, the sub-component that is ranked third overall is **CD3**, waste management by using sensors and data management which is also one of the components of smart utility. Rahim et al. (2015) conducted a study on discovering the waste and disposal generated from construction industry in Malaysia and deduced that 40% of waste and disposal comes from construction industry. There are a lot of significant impacts if the waste produced is not handled in the proper way. If the waste if left unattended at an empty land, the land will be contaminated which will then affect the quality of the soil and eventually dissolved into the ocean threatening the life of sea creatures. Diseases might spread among living population from the animals such as rats and insects like mosquitoes and flies after they feast on the disposal and spread to the citizens and communities. Pardini et al. (2020) highlighted that implementation of smart waste management system utilises sensors to monitor waste receptacle fill rates and to alert city collection services when bins are ready for emptying. Over a period of time, historical data collected by sensors can be used to classify the trend of clearing the bins and thus providing efficiency and effectiveness. Furthermore, the risk of missing pickups and overflows will be removed and reducing the rate of carbon dioxide emissions by collecting the waste on time. With the execution of smart waste management, the waste disposed by the construction site will be addressed accordingly. As a result, the risk of diseases spreading such as Aedes will be reduced as well.

On the other hand, **CG1** indicated the implementation of electronic learning (e-learning) was ranked with the lowest mean score of 3.48 by all the construction practitioners. According to Zhu, Yu and Riezebos (2016), developing new technology can help learners understand more quickly, easily, more flexibly and safer. Smart education is a term which uses digital for learning purposes. Learners use smart devices to access digital resources via wireless network and immerse in personalised and seamless learning which eventually leads to the spark of smart education. However, most of the respondents are currently working in the industry and did not experienced the usage of technology in studying as smart education was not introduced back then. Thus, the effectiveness of using technology to deliver education would be doubted by the respondents. Besides, the advanced digital devices such as laptops, smart phones and other electronics might poses as a distraction and it is inappropriate as it will disturb the focus of the study. The reason behind this is that all the young learners may be more interested in the digital devices rather than the education material being taught.

4.5 Kruskal-Wallis Test

Kruskal-Wallis test is used to determine the significant difference on the sub-components of smart sustainable city by different profession of construction practitioners. In order to deduce the significant differences, the p-value used in this test is set to be 0.05 and hence the critical chi-square value (H-value) would be 7.815. Two hypotheses are generated for this test as below:

Null hypothesis (H_0): There is no significant difference across the construction practitioners on the importance of components of smart sustainable city.

Alternative hypothesis (H_1): There is a significant difference across the construction practitioners on the importance of components of smart sustainable city.

Table 4.10: Kruskal-Wallis Test on Construction Practitioners

Code	Components	Chi-square (H-value)	Asymptotic Significance
CB3	Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application.	8.073	0.038
CE1	Use of autonomous machines such as robot and machines in supply chain management.	8.086	0.044

Table 4.10 shows the summary of the Kruskal-Wallis test which portrayed the significance different of construction practitioners towards the sub-components of smart sustainable city. The test identified two (2) elements that have significant differences across the four (4) profession of construction industry like architect, engineer, main contractor and quantity surveyor. Both of the items are **CB3** = "Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application" and **CE1** = "Use of autonomous machines such as robot and machines in supply chain management". The H-value of both sub-components had exceeded 7.815 and the asymptotic significance value of less than 0.05. On the other hand, the other sub-components have H-value of lesser than 7.815, therefore, there is no significant difference across the construction practitioners on the smart sustainable city sub-components. Hence, the alternative hypothesis (H_1) is accepted for **CB3** and **CE1**. The mean ranking of the both sub-components are generated in order to identify the degree of significance across the construction practitioners. The mean ranks are illustrated as shown in Table 4.11.

Table 4.11: Mean Rank of Smart Sustainable City Sub-Components Across Construction Practitioners

Code	Components	Profession	N	Mean Rank
CB3	Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application.	Architect	32	63.83
		Engineer	30	65.17
		Main Contractor	**30**	**69.71**
		Quantity Surveyor	*33*	*50.98*
CE1	Use of autonomous machines such as robot and machines in supply chain management.	Architect	32	59.45
		Engineer	30	57.92
		Main Contractor	*30*	*57.50*
		Quantity Surveyor	**33**	**66.97**

Note: **Bold** indicates the highest mean rank of construction practitioners on smart sustainable city sub-components.

Italic indicates the lowest mean rank of construction practitioners on smart sustainable city sub-components.

Referring to the Table 4.11, there is a significant difference between main contractor and quantity surveyor on the sub-component of **CB3** = "Information such as empty parking slot and fastest route to reach the desired destination can be obtained via application". The mean value of main contractor is 69.17 while the mean score for quantity surveyor is 50.98. It can be inferred that main contractor have higher agreement level on the importance of **CB3** compared to quantity surveyor. The role of main contractor in the construction industry requires them to travel from office to site almost every day to check on the situation at site and ensure the work progress is following the planned work schedule. Having the information of empty parking slot and uncongested route can prevent waste of time and ensure the work productivity. Besides, the main contractor required to attend for tender bidding and tender submission in order to secure a new project. Thus, any delay in arrival caused by traffic jams or looking for parking slots would not be ideal in the point of view of main contractor. Quantity surveyor on the other hand does not have to travel often from office to site and the task of work are almost office based. Hence, the information of empty parking slot and uncongested road is not as important as main contactors' needs for quantity surveyor.

Moving on, the second sub-component that has a significant difference of opinions between the construction practitioners is **CE1** which indicates the use of autonomous machines in supply chain management. Quantity surveyor with a mean rank of 66.97 agreed that the autonomous machines is very important in the supply chain management while main contractor only have 57.50 of mean score which shows that main contractor have the lowest agreement level on this sub-component. The result can be deduced as quantity surveyor required to prepare all the contractual documents and distributed the finalised version to various parties such as the client, architect, main contractor and necessary stakeholders. Thus, the quantity surveyor relies heavily on the autonomous machines to produce all the required documents. The task of the quantity surveyor would be relived as all the documents can be settled with just a click on the machines. While main contractor on the other hand, does not rely on the autonomous machines as much as quantity surveyor because the sole focus of the main contractor is on the work progress of the construction.

4.6 Refined Smart Sustainable City Framework

Figure 4.1 portrays the refined smart sustainable city framework with the sub-components of smart sustainable city based on the data analysed. In the proposed smart sustainable city framework in Chapter 2 (refer to figure 2.1), there are seven (7) main components of smart sustainable city. The proposed framework is modified and refined according to the ranking done by the construction practitioners.

There are seven (7) tiers shown in Figure 4.1 where smart data is ranked first with the highest mean value and smart education is located at the end of the due to the lowest mean value. The ranking of the components are based on the mean ranking obtained from the arithmetic means test with smart data as the highest mean score component overall and it is followed by smart energy, smart building, smart mobility, smart governance, smart logistic and lastly smart education. On top of that, the awareness of respondents towards smart sustainable city was ranked accordingly based on the five (5) dimensions. Human factor appeared to have the most awareness among the respondents while institutional factor has the least exposure to the respondents.

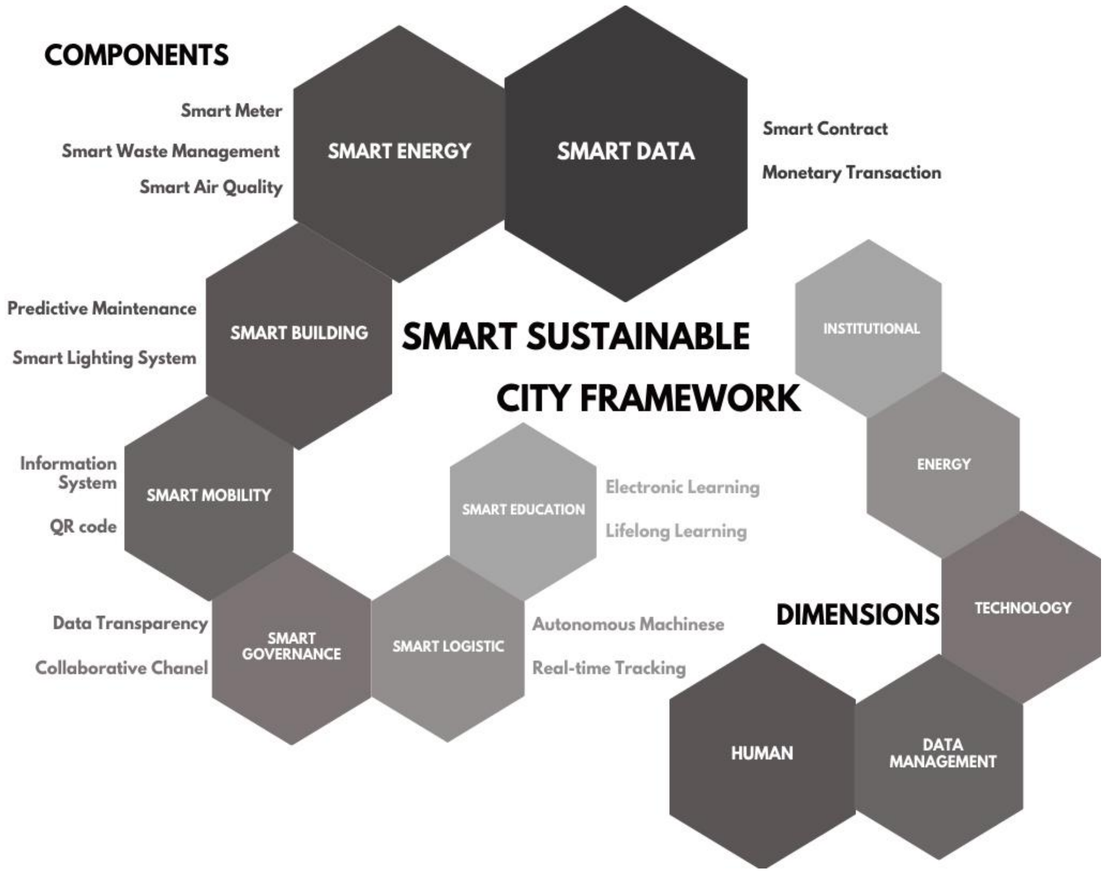

Figure 4.1: Refined Propose Smart Sustainable City Framework

4.7 Chapter Summary

This chapter has discussed in depth the awareness and sub-components of smart sustainable city across the construction practitioners. A total of 125 sets of questionnaire surveys were retuned and gathered where it consists of 32 sets from architect, 30 sets from engineer, 30 sets from main contractor and 33 sets from quantity surveyor. All the data collected were analysed by using Cronbach's Alpha Reliability Test, Arithmetic Means and Kruskal-Wallis Test.

In order to differentiate the data from the construction practitioners, the demographic details were tabulated and summarised. Then, the Cronbach's Alpha test depicts the internal consistency of the data and deducing great reliability of the data obtained. From the mean test on the awareness of respondent towards smart sustainable city, the respondents are aware of the human factor in achieving smart sustainable city. Nevertheless, the institutional dimension received the lowest exposure as the mean value is the lowest among the other dimensions. Moving on, the components and sub-components of smart sustainable city was scaled and ranked by the respondents. A modified and refined proposed smart sustainable city framework was illustrated based on the results generated from the mean test. Lastly, Kruskal-Wallis test was conducted to identify any significant difference between the sub-components of smart sustainable city across the four (4) construction professionals. Two sub-components were found to have significant difference between main contractor and quantity surveyor which are **CB3** and **CE1**.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This final chapter sums up all the chapters in this study. In the beginning of the chapter, an overview of all the chapters. Then, the research approaches utilised to achieve the research objectives are included in the next section. On top of that, the limitations faced in this research will be discussed in detail and some recommendations are given in order to improve more for future research. Lastly, a brief discussion of the contribution from this research to the industry and body of knowledge will wrap up this chapter.

5.2 Accomplishment of Research Objectives

In this study, the background and problem statement related to smart sustainable city is expressed at the beginning. The rapid growth of population will cause significant negative impacts such as urbanisation and resource depletion to happen if the situation is not handled properly. Thus, in order to counter all these major issues, several researches had been carried out and it was found out that the implementation of smart city would be the optimal solution to tackle the resource scarcity crisis (Silva, Khan and Han, 2018).

Understanding what, and how, the smart city operates is key. Höjer and Wangel (2015) indicated that smart sustainable cities should be assisted by smart application of various Information and Communication Technology (ICT) and focused on citizens ' needs without harming future generations or others. In addition, Martinidis (2019), discovered that smart cities would be beneficial in improving citizens' quality of life, increasing resource efficiency, reducing congestion and pollution, ensuring security, accelerating economic development and many more. However, there are few studies based on smart city's elements and components, and how it achieves sustainability. There are also limited studies on the awareness and component of smart sustainable city in Malaysia. Therefore, there is a need to conduct a research to identify the components of smart sustainable city in order to fill up the gap of knowledge in Malaysia. The research aimed to propose a smart sustainable city framework for Malaysia and all three (3) of the research objectives were identified in the first chapter as well. The research scope of limited to construction practitioners only because construction professionals plays huge role in the process of setting up the smart sustainable city system in Malaysia. The accomplishment of each research objective is discussed in the next section.

5.2.1 Objective 1: To determine the awareness of smart sustainable city in Malaysia.

The first objective of this study was achieved based on the data analysis done on chapter four (4). The definition, benefits and dimensions of smart sustainable city were stated in the questionnaire survey and the respondents were required to scale and rank based on their agreement level on the particular statement. A mean ranking test was carried on the data obtained and the result showed that most of the respondent agreed on the factor that human support such as knowledge and creativity enable the success of building a capable smart sustainable city. Nevertheless, the respondent is less aware that the government holds a huge role in promoting smart sustainable city as well. Based on Table 4.5, the respondents are more aware to the human aspect in the dimension of smart sustainable city among all of the other elements. The institutional dimension received the least attention from the respondents as most of the respondents are not familiar with it thus, resulting in a lower mean score value for institutional aspect.

5.2.2 Objective 2: To identify the components of smart sustainable city in Malaysia.

The second objective was achieved by reviewing the journals, articles, books and internet for more sources of information. Seven (7) main components such as smart governance, smart mobility, smart building, smart energy, smart logistic, smart data smart education were identified from the literature review. Then, the main components were broken down into seventeen (17) sub-components that draw the function and role of the main component in smart sustainable city. The components of smart sustainable city were ranked based on the value of mean scoring. Smart data deemed to be the most important component in smart sustainable city while smart education ranked as the least important component from the construction practitioner perspective.

5.2.3 Objective 3: To propose a smart sustainable city framework for Malaysia.

A preliminary framework was proposed in the literature review part. However, after conducting mean ranking based on the data obtained from respondents, a refined proposed smart sustainable city framework was depicted as shown in Figure 4.1. There are seven (7) main components of smart sustainable city ranked based on the mean value achieved from arithmetic test. The sub-components of each main component were further broken down. The larger the component in the framework indicates higher ranking by the construction practitioners. Additionally, the dimensions of smart sustainable city were evaluated by the respondents and the ranking of dimensions are done based on the mean value calculated. Human factor showed up as the top dimension voted by the respondents which also portrayed that the respondents realise the importance of human support in pursuing smart sustainable city. Nevertheless, institutional did not gained as many acknowledgements as human factor and hence ranked as last among all the dimensions.

5.3 Research Limitations

There are a few limitations in this research that are needed to be considered. First of all, the survey distribution method was through email which would affect the purity of the data collected regarding to the awareness of the respondents. The respondent might not understand the meaning and function of smart sustainable city at the first place when receive the email. The respondent could browse through the internet and read through relevant documents or summary about smart sustainable city then only answer the survey. Thus, in this study, this distribution method has some limitations such as the samples being unreliable and less control over the accuracy of the data.

Additionally, the proposed framework in this research could not be verified and validated by professional institutions during the research period. Therefore, the proposed framework is only a preliminary framework to be studied further in the future. Next, there was a disproportionate distribution of respondents. Based on the table tabulated in Table 4.1, majority of the respondent were having working experience lesser than 6 years. A balanced distribution of the respondents is ideal in obtaining an equilibrated experience from different perspectives. In addition, the research scope of this study is only limited to construction practitioners in Malaysia. Hence, all the data tabulated and mean ranking are based on the perspective of construction practitioners.

Lastly, the proposed smart sustainable city framework did not verify by any professional parties during the whole period of this research.

5.4 Research Recommendations

In order to tackle with the limitations faced in previous section, distribution of survey by hardcopy would record the spontaneous and the actual reaction of the respondent to the questionnaire. This would enhance and ensure the purity and reliability of the data collected and thus, inducing a better and more accurate of level of awareness of construction practitioners towards smart sustainable city.

Further studies can be conducted to validate the proposed smart sustainable city framework. The validation of framework can be accomplished through interviews, focus group discussion or case studies to validate the applicability of the proposed framework. Besides, interviews can be conducted after identifying a list of competitive strategies from literature review. The purpose of conducting the interviews is to ensure the reliability of the results.

5.5 Research Contribution

The proposed smart sustainable city framework could be shared and disseminated to the Malaysian Government such as the Federal Town and Country Planning Department or to the related professionals' bodies. Some actions can be done by the public authorities to increase the level of awareness of citizens towards smart sustainable city. The five (5) dimensions of promoting smart sustainable city should be encouraged. Institutional organizations shall empower the use of technology to improve the quality of daily life. On top of that, government could spread the benefits of smart sustainable city in the collaborative channel with the citizens to increase the awareness among citizens. Moreover, the government and relevant parties can refer to the components of the smart sustainable city in planning the future smart city for Malaysia.

The proposed smart sustainable city framework could contribute to the existing literature and to be used for future research as well by identifying and adding more smart sustainable city components in order to further refine the framework. Not to mention, other researchers and countries could refer to the smart sustainable city framework while considering the economic and culture difference when developing the personalised smart sustainable city framework.

5.6 Chapter Summary

As the conclusion for this chapter, all the previous findings have been briefly deduced. Besides, all the research objectives have been successfully achieved. The limitations of the research were addressed and explained. Conversely, the recommendations to improve the quality of future research were pointed out as well. Lastly, the research contributions were identified in the last part of the chapter.

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APPENDIX

APPENDIX A: Questionnaire for Construction Practitioners

Dear Sir/Madam,

I am Tan Khai Zhi, a final year Quantity Surveying student from Lee Kong Chian Faculty of Engineering & Science (LKC FES) at Universiti Tunku Abdul Rahman (UTAR). Currently, I am conducting a survey for my Final Year Project entitled "Exploring the components of Smart Sustainable City", a partial fulfillment of my Bachelor of Science (HONS) Degree program in Quantity Surveying. The purpose of this research is to identify and propose a smart sustainable city framework that could be implemented in Malaysia in future.

I believe that your professional experiences and knowledges will shine a light on this research. Your participation in this survey will significantly contribute to this study and will add unmeasurable value to the Construction Industry and development of the country.

It will be highly appreciated if you could spend 5 minutes of your valuable time to fill up this survey. Your responses will be kept confidential and used solely for academic purposes.

If you have any questions about this survey, please do not hesitate to contact me for further information.

Student name: Tan Khai Zhi
Contact number: 016-3911314
E-mail: khai.zhi@1utar.my

Thank you for your participation and time.

Section A: Demographic Section

Please tick (✓) in the relevant box.

What is your age group?

- Less than 21 years old
- 21 - 30 years old
- 31 - 40 years old
- 41 - 50 years old
- More than 50 years old

What is your profession?

- Architect
- Building Supplier
- Engineer
- Main Contractor
- Project Manager
- Quantity Surveyor
- Sub-Contractor
- Other, please specify ___________

How long have you been working in construction industry?

- Less than 6 years
- 6 – 10 years
- 11 – 15 years
- 16 – 20 years
- More than 20 years

What is your highest educational level?

- Sijil Pelajaran Malaysia (SPM)
- Sijil Tinggi Persekolahan Malaysia (STPM)
- Diploma
- Bachelor’s Degree
- Master’s Degree
- Doctoral
- Other, please specify ___________

Do you think the city at the moment is considered as smart and sustainable?

- Strongly Disagree	- Disagree	- Neutral	- Agree	- Strongly Agree

Do you think the city in the future will be smart and sustainable?

- Very Unlikely	- Unlikely	- Neutral	- Likely	- Very Likely

Section B: Understanding of Smart Sustainable City (SSC)

Please rank each question from scale 1 (Strongly Disagree) to 5 (Strongly Agree) by ticking (✓) at the relevant options about your understanding on Smart Sustainable City (SSC).

Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1	**2**	**3**	**4**	**5**

	What is Smart Sustainable Cities (SSC)?	**1**	**2**	**3**	**4**	**5**
1	SSC is used to overcome the risk of resource scarcity in the future.	O	O	O	O	O
2	SSC will ensure the quality of life of citizen.	O	O	O	O	O
3	SSC scales down environmental footprint.	O	O	O	O	O
4	SSC is powered by smart connections for various items.	O	O	O	O	O
5	SSC utilizes cognitive technologies such as Artificial Intelligence (A.I.) and Internet of Things (IoT).	O	O	O	O	O
6	Government support is the backbone of SSC development.	O	O	O	O	O
7	SSC is triggered by various creativity and innovation to improve development.	O	O	O	O	O
8	SSC is a digital city that connects community and combines communications infrastructure.	O	O	O	O	O
9	Humanity support such as knowledge economy enables success of building a capable SSC.	O	O	O	O	O
10	SSC helps in elevating the economy of a country by increasing efficiencies and effectiveness through technology.	O	O	O	O	O

Section C: Components of Smart Sustainable City (SSC)

Please rank each question from scale 1 (Not Important) to 5 (Very Important) by ticking (✓) at the relevant options about your opinions on the components of Smart Sustainable City (SSC).

Not Important	**Less Important**	**Neutral**	**Important**	**Very Important**
1	**2**	**3**	**4**	**5**

	Components of Smart Sustainable City (SSC):	**1**	**2**	**3**	**4**	**5**
1	Transparency of government data such as incomes and expenses can be viewed by citizen.	O	O	O	O	O
2	Citizen can provide ideas and voice out opinions to government to overcome the issue they are facing.	O	O	O	O	O
3	Car pooling or bike sharing can be done through applications or by Quick Response code scanning.	O	O	O	O	O
4	Video surveillance cameras provide real time traffic data to prevent and solve traffic situation such as congested roads and accidents.	O	O	O	O	O
5	Information such as empty parking slot and fastest route to reach the desired destination can be achieved via application.	O	O	O	O	O
6	Data obtained from sensors in a building can help to generate and deduce a predictive maintenance.	O	O	O	O	O
7	Lighting control system of a house or building can be done through application to reduce energy consumptions.	O	O	O	O	O
8	Installation of solar panels on the roof can generate electricity replacing burning of fuel resources.	O	O	O	O	O
9	Greenhouse effect can be prevented by measuring and monitoring the carbon footprint produced.	O	O	O	O	O
10	Garbage and disposal will be automatically collected when the bin is full by having sensors sending data to the management.	O	O	O	O	O

11	Air quality can be monitor and controlled by measuring the pollution level with sensors on top of the building or around the streets.	O	O	O	O	O
12	Implementation of autonomous machines such as robot and heavy load machines in supply chain management.	O	O	O	O	O
13	Real time shipment tracking data of goods ensure safety and security of the product to the consumer.	O	O	O	O	O
14	Confidential data such as contracts and agreements can be stored safely in secured network.	O	O	O	O	O
15	Paying fees or conducting monetary transaction can be done through online anytime and anywhere.	O	O	O	O	O
16	Innovation of electronic learning (e-learning) enables classes to be carried out through online	O	O	O	O	O
17	Lifelong learning can be achieved easily by browsing through the internet with the help of Internet of Things (IoT)	O	O	O	O	O