SMART SUSTAINABLE CITY READINESS IN MALAYSIA

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SMART SUSTAINABLE CITY READINESS IN MALAYSIA

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A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Science (Honours) 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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ABSTRACT

Urbanisation is accelerating in developing countries, leading to increased resource consumption, environmental degradation, and challenges in sustainable urban planning. Smart sustainable cities have emerged as integrated solutions that leverage technology and efficient resource management to support environmentally responsible and livable urban development. While most studies focus on defining smart sustainable cities and their technological components, limited research evaluates the readiness of cities, especially in Malaysia, for such a transformation. Evaluating city readiness and prioritising quality of life are key to a successful, inclusive shift to sustainability. Thus, this study aims to evaluate the readiness level of Malaysian cities towards a smart sustainable city. Four main criteria for assessing the readiness level of cities for becoming smart sustainable cities were identified through literature review, namely Human Aspects, Technology Aspects, Economic Aspects, and Governance Aspects. Eight strategies to improve the readiness level were then discovered such as Educational and Awareness Campaigns, Financial Incentives and Subsidies, Infrastructure Development, Policy and Regulatory Frameworks, Comprehensive Data Strategy, Pilot and Scale Smart Solutions, Planning for Long-Term Sustainability, and Secure Funding and Resources. Questionnaires were distributed to residents in Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam, with 100 valid responses collected. Data analysis results indicated that Technology Aspects ranked highest among smart sustainable cities, while Human Aspects led among non-smart sustainable cities. Infrastructure development was found to be the most effective improvement strategy. The result of Spearman's Correlation Test showed that citizens' readiness to use IT-based services and technologies is the most significant criteria and the organisation of campaigns to increase public awareness is a noteworthy strategy. Besides, significant differences in smart sustainable city readiness were observed across age, education level, income level, ethnicity, gender, marital status, residential state, and income type. This study supports Malaysia's smart sustainable cities transition by assessing cities' readiness and offering practical strategies to guide agencies like Jabatan Kerja Raya and

Construction Industry Development Board in aligning infrastructure and construction with smart sustainable goals.

Keywords: smart sustainable city, sustainability, city readiness, strategies, urbanisation

Subject Area: HT165.5-169.9 City planning

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LIST OF SYMBOLS / ABBREVIATIONS

e	margin of error
n	sample size
p	the proportion of the population with attributes understudy
q	1 – p
z	the z-scores of the desired confidence level

AI	Artificial Intelligence
BIS	Business, Innovation, and Skills
CIDB	Construction Industry Development Board
CLT	Central Limit Theorem
CRI	Change Readiness Index
DIGO	Delivering Information of Government
DPP	Digital Participatory Planning
DR	Demand Response
DSM	Digital Social Market
ELENA	European Local Energy Assistance
ICT	Information and Communication Technology
IoT	Internet of Things
IT	Information Technology
ITMS	Intelligent Traffic Management System
JKR	Jabatan Kerja Raya
KLIA	Kuala Lumpur International Airport
ML	Machine Learning
Non-SSCs	Non-Smart Sustainable Cities
PPP	Public-Private Partnership
SDG	Sustainable Development Goal
SPM	Sijil Pelajaran Malaysia
SPSS	Statistical Package for the Social Sciences
SSC	Smart Sustainable City
SSCs	Smart Sustainable Cities
STPM	Sijil Tinggi Persekolahan Malaysia
SUMP	Sustainable Urban Mobility Plan

TOD	Transit-Oriented Development

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter provides a comprehensive overview of the study, detailing the importance of this study, problem statement, aim, objectives, research methodology, scope, and chapter outlines.

1.2 Background of the Study

Urbanisation is a dynamic process that transforms the social and economic capacities of rural, agriculturally based communities to urban centers dominated by industry and services, affecting the quality of the world's environment and resource usage patterns (Shahbaz *et al.*, 2015). Udemba, Philip and Emir (2022) indicated that Malaysia is experiencing rapid urbanisation, with nearly 77% of its population residing in urban areas driven by better job prospects and robust economic growth. This urban concentration has led to increased energy demand and environmental degradation stemming from industrial operations, transportation and household consumption (Udemba, Philip and Emir, 2022). According to Addai *et al.* (2024), population growth and urbanisation drive heightened resource consumption, habitat destruction, and pollution, all of which significantly contribute to environmental degradation. Throughout numerous developing nations, governments are grappling with the challenges of planning and overseeing the rapid growth of urban areas and the resulting consequences including high energy consumption, traffic congestion, and climate change which are affecting the development of sustainable city (Almulhim and Cobbinah, 2023). Advancing the country while simultaneously safeguarding the environment is essential. In this regard, smart sustainable cities (SSCs) play a crucial role.

A SSC is a well-managed metropolitan area that uses communication and information to support both the mobile world driven by wireless networks and the internet to give a high standard of life (Lim, Edelenbos and Gianoli, 2019). By 2050, the United Nations anticipated that cities will be home to more than 6.6 billion people, with nearly 68% of the global population embracing urban life (Ma *et al.*, 2024). This urban concentration facilitates the implementation of SSC initiatives by providing a concentrated population base that can benefit from and contribute to smart infrastructure and services. The SSC model, viewed through engineering and socioeconomic lenses, enhances resource management and public services by integrating urban systems like infrastructure, environment, transport, energy, water supply, and security (Kim and Feng, 2024). It also fosters knowledge-based and eco-friendly economic and social environments, attracting tech-driven industries, supporting a low-carbon economy, and promoting sustainable growth.

To avoid disregarding the sustainability dimension, the International Telecommunication Union Focus Group on SSC promotes "Smart Sustainable Cities" as an alternative to "Smart Cities" (Ibrahim, El-Zaart and Adams, 2018). Smart cities, often criticised for their focus on being technology hubs have been increasingly scrutinised for prioritising technological advancements over sustainability objectives, thereby failing to integrate comprehensive solutions for urban development (Chatti and Khan, 2024). Sustainability and smartness are interconnected, as the technological aspects of SSCs capture real-time data and feedback on Sustainable Development Goal (SDG) indicators, empowering stakeholders to implement and fine-tune programs for maximum impact strategically (Sharifi *et al.*, 2024). In China, SSCs are harnessed as catalysts for economic transformation, turning traditional manufacturing into technology-driven industries, thereby reducing pollution and aligning with sustainable urban vision (Kim and Feng, 2024). Given the rapid urbanisation in Malaysia, this research focuses on SSC as a solution to address the challenges of urbanisation, leveraging its benefits to enhance sustainable growth and urban management.

1.3 Problem Statement

Over the past two decades, the concept of a SSC has continued to evolve, encompassing a framework that involves government administration, economy, citizens, quality of life, environment, and transportation, along with their respective subsystems (Qian *et al.*, 2024). The majority of prior research has concentrated on establishing a clear definition and the concept of what constitutes a SSC, delving into its core principles and identifying the key elements that contribute to its sustainability and intelligence. Secinaro *et al.* (2022) adopted the six dimensions of SSC to clarify the definition and concept of SSC in Italy. Furthermore, Cai *et al.* (2023) defined SSC by using four main categories, namely technology, concept, integrated system and data in the United States. Similarly for Canada, six key urban-focused elements including economy, environment, living, people, transportation and government were used to define the SSC concept by Pira (2021).

On the other hand, numerous previous studies discussed the application of smart technology in SSC. For example, Bibri (2019) examined the application of big data in the context of SSC in Norway. Correspondingly, Siddiquee *et al.* (2022) addressed the blockchain technology application in relation to the SSC in France. The success of SSC stems from the integration of computing and Information and Communication Technology (ICT) with scientific disclosure and its societal implications were reviewed by Bibri and Krogstie (2017). Moreover, Aina (2017) explored the use of information to analyse Saudi Arabia’s experience in using Geoinformation and Communication Technology for SSC. The Internet of Things (IoT) that is widely used in China which emphasises its integral role in the development of SSC as expressed by Liu (2018). In addition, Wong *et al.* (2020a) examined how blockchain technology is being applied in the development of SSCs in Malaysia.

Furthermore, considering that the SSC is a new concept, several studies assessed the readiness of citizens for transforming to SSC. Beştepe and Yildirim (2022) investigated the acceptance of IoT-based and sustainability-oriented SSC services as user attitudes are critical to the adoption and expansion of technology. On the other hand, Wong, Tan and Lou (2024) evaluated the acceptance level of blockchain technology in SSC among construction practitioners in Malaysia. Next, Liu *et al.* (2024) created a decision-making approach to prioritise the supply and demand of smart city services from citizens' perspective.

In spite of that, a limited number of studies are devoted to the readiness level of the city for SSC transformation. There is a scarcity of research assessing the readiness level of the city itself for transforming into a SSC especially in Malaysia. Instead of solely focusing on transforming a city to achieve sustainability, it is essential to prioritise the quality of life for its citizens and assess the city's readiness for change while developing comprehensive and effective solutions to ensure a successful and beneficial transition for all residents (Ibrahim, El-Zaart and Adams, 2018). Hence, by determining the city readiness level, appropriate strategies can be implemented to ensure a seamless transformation process. As a result, it is vital to conduct research to investigate the city readiness level for transforming into a SSC in Malaysia.

1.4 Aim and Objectives

This study aims to assess the readiness level of Malaysian cities towards a smart sustainable city.

To achieve the aim of this study, three objectives were established:

i. To compare the readiness levels of Smart Sustainable Cities and Non-Smart Sustainable Cities.

ii. To identify strategies for improving the readiness level of cities to become Smart Sustainable Cities.

iii. To assess the effect of sociodemographic factors on city readiness towards SSC.

1.5 Scope of the Study

This study focuses on residents located at Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam, without restrictions on age, gender, profession, or educational level. The goal is to gather a broad range of responses from a diverse demographic. Putrajaya and Cyberjaya were selected because they are already established as SSCs in Malaysia. In contrast, Kuala Lumpur and Shah Alam (non-SSCs) were chosen as it is positioned as a key city for developing into a SSC through the US-ASEAN Smart City Partnership (Samsudin *et al.*, 2022).

1.6 Research Methodology

A quantitative approach was employed which the data was collected through a questionnaire distributed via email, social media and professional networks platforms such as LinkedIn. Out of 113 responses received, 13 were excluded for being outside the research scope, leaving 100 valid responses analysed using

Cronbach's Alpha Reliability Test, Arithmetic Mean, Spearman's Correlation Test, Kruskal-Wallis Test, and Mann-Whitney U Test.

1.7 Outline of the Report

This study comprises five chapters. Chapter one begins with an introduction that includes the background of study and problem statement. The problem statement uses previous studies to describe the research problem and the research gap. The research aims, objectives, scope, chapter outlines, and a summary of this chapter will be addressed subsequently. In addition, chapter two presents the literature review of this research. This chapter discusses previous studies about the readiness level of cities for becoming SSCs, strategies to improve the readiness level and the effect of sociodemographic factors on city readiness.

Chapter three examines the methodologies used for data collection and analysis to meet the research aims and objectives. This chapter covers both the data collection strategy and the data analysis approach. Next, chapter four presents a comprehensive interpretation of the data obtained and the findings derived from the analysis. Finally, chapter five reviews the accomplishment of the research objectives and highlights the contributions of this study, while also addressing the limitations faced and offering recommendations for future studies.

1.8 Summary of Chapter

To conclude, the research identified a gap in understanding the readiness of cities to become SSC, which focused the study and clarified the problem statement. Consequently, the research aims and objectives were formulated to address this gap. Furthermore, this chapter provided a detailed presentation of the research methodology and chapter outline.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter compiles an overview of the pertinent literature concerning the level of cities for becoming SSCs. It begins by presenting the definition, concept of SSC, and SSCs in Malaysia and other countries. Following this, the chapter explores and evaluates strategies to enhance city readiness towards SSC and examines the impact of sociodemographic factors on city readiness.

2.2 Smart Sustainable City (SSC)

The section provides a comprehensive discussion on the definition and concept of a SSC.

2.2.1 Definition of Smart Sustainable City

SSC is described as a city that makes use of ICTs and other tools to boost competitiveness, quality of life, and the effectiveness of urban operations and services (Kim and Kim, 2022). SSC uses advanced technologies and data analytics to enhance the quality of life for its citizens, promote sustainable development, and optimise resource management. It balances economic growth, environmental protection, and social well-being through smart infrastructure and efficient public services. According to Belli *et al.* (2020), SSC integrates urban sustainability with municipal smartness, emphasising that environmental sustainability and advanced technological infrastructure must be developed together to achieve optimal urban performance. In broad terms, a SSC harmoniously integrates physical, Information Technology (IT), social, human, and business infrastructures to achieve collective intelligence, leveraging interconnected information to enhance understanding, improve operational control, and optimise limited resources.

2.2.2 Concept of a Smart Sustainable City

Historically, the concept of SSC has aimed to revolutionise urban areas by integrating innovation, intelligence, and advanced technology. However, the concept has evolved beyond its original ideology to offer solutions to a variety of urban challenges including emissions of greenhouse gases, wastage of public resources and traffic congestion through technological advancements (Antwi-Afari *et al.*, 2021). The SSC concept comprises six urban-focused elements, namely economy, environment, living, people, transportation, and government, each encompassing various indicators from educational metrics to green energy initiatives (Pira, 2021). To become truly smart, city elements and indicators must be managed through complex and integrated solutions that holistically address various urban challenges and opportunities, ensuring efficient, interconnected, and sustainable urban development (Mozūriūnaitė and Sabaitytė, 2021).

2.2.3 Smart Sustainable Cities in Malaysia and Other Countries

SSC initiatives have gained global traction, including in Malaysia, where the development of SSC began with the Multimedia Super Corridor initiative in the 1990s, notably developing Cyberjaya with smart technologies to improve living standards and sustainability (Bakhtiar and Samsudin, 2023). Bakhtiar and Samsudin (2023) indicated that the Malaysian Ministry of Science also backs this effort with a national IoT strategic roadmap aimed at boosting IoT adoption in various sectors, including SSC. SSC initiatives in Malaysia are divided into seven primary components, namely smart governance, smart mobility, smart people, smart environment, smart economy, smart living and smart digital infrastructure, each contributing to the implementation of strategies and initiatives and forming a solid framework for tackling urban problems and key challenges (Samsudin *et al.*, 2022). Samsudin *et al.* (2022) gave an example by stating that the Malaysia Urban Observatory, established by PLANMalaysia, collects urban data from national agencies to make governance-related information and solutions more easily accessible.

SSC prioritises sustainable economic development while maintaining a high standard of living by funding both conventional and contemporary communications infrastructure, investing in human and social capital, and managing natural resources through participatory policy-making. In Philippine, as a result of the Department of Information and Communications Technology (ICT) setting up free Wi-Fi in quarantine centers to allow medical professionals to connect with their families and expedite the collection and reporting of COVID-19 data during the pandemic, Manila is ranked among the top seven cities in the world for self-reported digital skills in coding, troubleshooting, technical issues, and threat mitigation (Chong *et al.*, 2022). In the meantime, the Jakarta government in Indonesia has used digital infrastructures such as online platforms and software applications to implement six SSC aspects; nevertheless, there is still a need to enhance public usage and raise public awareness of these apps (Chong *et al.*, 2022). Besides, due to the government's desire to use ICT for economic growth, the ICT infrastructure of Vietnam began to rise quickly in 1995, showcasing how SSC technology might help emerging nations handle the effects of fast urbanisation (Vu and Hartley, 2018).

In China, the State Council of the People's Republic of China has proposed measures to speed up the process of granting permanent urban residency to qualified rural-to-urban migrants in order to support the development of livable, resilient and smart cities, demonstrating the government's commitment to promoting the growth of SSC in the contemporary era (Chong *et al.*, 2023). Additionally, Intelligent Transportation Systems have been introduced in China to improve urban mobility economically and environmentally through vehicle-network integration (Xu, Lin and Yu, 2024). In contrast to the conventional top-down strategy that uses ICT to control infrastructure, Europe's manifesto on citizen participation places a strong emphasis on the value of collaboratively developing solutions for SSC (Preston, Mazhar and Bull, 2020). Preston, Mazhar and Bull (2020) also asserted that the potential usefulness of citizen-driven initiatives was indicated by the previous UK Department for Business, Innovation and Skills (BIS), which emphasized that smart cities should be "liveable and resilient", with an increased role for citizens to participate with services customized to their requirements.

2.3 Criteria for Measuring City Readiness towards Smart Sustainable City

Assessing the city's readiness for transformation into SSC is crucial before initiating any planning or implementation of change activities. The criteria for measuring city readiness towards SSC encompass human aspects, technology aspects, economic aspects, and governance aspects. Table 2.1 tabulates a list of criteria for measuring city readiness from previous studies.

Table 2.1: Previous Studies on Criteria for Measuring City Readiness towards SSC

No.	Criteria for Measuring City Readiness	Previous Studies
	Human Aspects	
1	Citizen's Participation	Sameer *et al.* (2023); Chatfield and Reddick (2016); Bouzguenda, Alalouch and Fava (2019); Kamnuansilpa *et al.* (2020); Anthony (2023)
2	Citizen's Awareness	Kamnuansilpa *et al.* (2020); Alamoudi, Abidoye and Lam (2023)
3	Community's Readiness	Antoni, Arpan and Supratman (2020)
	Technology Aspects	
4	Introduction of Robotics and IoT	Serrano (2018); Belli *et al.* (2020); Jo *et al.* (2021); Popescul *et al.* (2024)
5	Data Sharing Across Different Sectors	Khawaja and Javidroozi (2023); Leong, Heng and Leong (2023); Mutiarin and Lawelai (2023)
6	Adoption of Blockchain Technology	Khawaja and Javidroozi (2023); Wong *et al.* (2020b)
7	Utilisation of Machine Learning	Chen and Zhang (2024)
8	Implementation of Smart Mobility	Bielińska-Dusza, Hamerska and Żak (2021); Lhakard (2021); Hong and Wong (2017)
	Economic Aspects	
9	Efficient Resource Allocation	Ibrahim, El-Zaart and Adams (2018)
10	Adoption of Circular Economy	Formisano *et al.* (2022); Gonzalez *et al.* (2023); Dincă *et al.* (2022); Aceleanu *et al.* (2019)
11	Environmental Considerations	Formisano *et al.* (2022)
	Governance Aspects	
12	Government's Capacity to Innovate	Arief *et al.* (2020)
13	Sufficient Vision, Policies, Initiatives and Governance	Achmad *et al.* (2018); Su, Miao and Wang (2022); Noori, De Jong and Hoppe (2020); Cavada, Tight and Rogers (2019); Talib and Muhammad Taib (2024); Lim and Yigitcanlar (2022)
14	Smart Governance by Using Technology	Antoni, Arpan and Supratman (2020); Tomor *et al.* (2019)

2.3.1 Human Aspects

Bouzguenda, Alalouch and Fava (2019) emphasised that an equitable and sustainable growth strategy utilising a balanced blend of smart people, policies, and technology is the only way to create a smart and sustainable city. Sameer *et al.* (2023) stated that the SSC has focused mostly on how technology may lessen the problems associated with urbanisation, paying little attention to stakeholder's astute participation in the planning phase. In order to generate a shared vision and plan for the development of more environmentally, socially, and economically sustainable communities, citizen participation is essential (Chatfield and Reddick, 2016). Besides, practical community involvement strategies have been shown to improve social sustainability (Bouzguenda, Alalouch and Fava, 2019). In other words, the readiness level of a citizen to transform to SSC is a crucial factor in implementing SSC.

Kamnuansilpa *et al.* (2020) claimed that inadequate citizen involvement has led to some SSC initiatives falling short of their objectives. However, increasing citizen awareness of public projects enhances their engagement and provides valuable input and feedback for service production and delivery. Alamoudi, Abidoye and Lam (2023) asserted that citizen participation is vital for transforming SSC, with studies showing that countries encouraging citizen involvement significantly outperform those that do not in urban projects. On the other hand, the community's readiness to adopt an IT-based SSC has been evaluated by the Banyuasin District Government in Indonesia due to the importance of this readiness data (Antoni, Arpan and Supratman, 2020). It helps the government to assess how well-prepared of the citizens are in SSC. Thus, it is crucial to assess citizen readiness thoroughly before a city can successfully transform into a SSC, as their readiness plays a pivotal role in the transition process. Essentially, citizens are actively involved in the transformation of SSC, it indicates their readiness and willingness to embrace and contribute to this change.

2.3.2 Technology Aspects

The introduction of robotics and the IoT in the industrial sector, along with larger SSC solutions, has allowed governments to introduce digitalisation, resulting in smarter infrastructure (Serrano, 2018). Shwedeh *et al.* (2022)

indicated that technology readiness is critical to the sustainability and effectiveness of SSC, and there is proof that Dubai's cutting-edge technology has aided in its quick conversion to a SSC. Hence, there is a connection between technological advancement and the readiness to transition into a SSC. It is crucial for the various sectors of a city to be able to freely connect with one another and share data in order to truly benefit from SSC (Khawaja and Javidroozi, 2023). Blockchain technology was presented by Khawaja and Javidroozi (2023), which also showed how its use in the creation of SSC may result in more transparent, safe and effective processes. Wong *et al.* (2020b) expressed that most nations are going digital and recognising the possible uses of blockchain technology, and how Dubai has used blockchain technology to explore e-Democracy.

The IoT paradigm, with its multitude of connected devices that sense and adapt to their environments, guides technological evolution and involvement across various contexts, enabling SSC to enhance multiple facets of urban management (Belli *et al.*, 2020). By using IoT technology, a city may make a smooth transition to SSC setting. For instance, Korea has created ICT-driven smart cities to improve industrial ecosystems, industry value chains, and production route chains, all of which support the country's competitiveness (Jo *et al.*, 2021). Additionally, the goal of the SmartSantander project was to establish an experimental test facility in Europe for conducting research and testing on IoT applications, services, and key supporting technologies in the context of SSC (Popescul *et al.*, 2024). The statement implies that the IoT is a critical component of a SSC.

Bielińska-Dusza, Hamerska and Żak (2021) declared that sustainable mobility appears to be a prerequisite for the existence of SSC, and sustainable mobility cannot exist in the absence of intelligent solutions. As an example, the Sustainable Urban Mobility Plan (SUMP) is a comprehensive and strategic instrument that helps organisations and municipal authorities implement transportation policies in cities while successfully managing the intricacies of urban transportation (Bielińska-Dusza, Hamerska and Żak, 2021). Further, integrating a systematic transportation network with revolutionary technologies like machine learning (ML) can seamlessly enhance the transformation of SSC (Chen and Zhang, 2024). The Khon Kaen Smart City Project in Thailand makes use of Transit-Oriented Development (TOD) by putting in place technology hubs for smart mobility, utilising the regions served by all five rail lines to provide activities for its citizens and reduce traffic through enhanced public transit (Lhakard, 2021).

2.3.3 Economic Aspects

The goal of SSC is to develop sustainable urban areas by implementing change initiatives that integrate local interests and address social, economic, and environmental needs across all city levels (Ibrahim, El-Zaart and Adams, 2018). On the other hand, the circular economy helps create sustainable processes by reducing resource input, waste, emissions, and energy leakage through recycling and renewable energy, enabling cities to transform into sustainable circular smart systems with the right initiatives (Formisano *et al.*, 2022). Therefore, efficient resource allocation is necessary to guarantee the readiness of the city for the transition to SSC.

A circular economy aims to replace the conventional "take-make-dispose" framework with a sustainable system that maximises resources, minimises waste, and designs goods for recycling, repair, and reuse (Gonzalez *et al.*, 2023). By encouraging programs that support a sustainable, low-carbon, resource-efficient, and competitive economy, the European Union works to meet the SDGs and encourages the circular economy's responsible resource usage (Dincă *et al.*, 2022). Numerous European Union nations such as the Netherlands, Germany and the United Kingdom have put in place specific measures with the goal of advancing the circular economy through policies and pilot projects (Aceleanu *et al.*, 2019). These activities highlighted the need for environmental considerations to be taken into account while designing and implementing SSC programs, aligning with the readiness to transition towards becoming SSC (Formisano *et al.*, 2022). Environmental considerations in SSC programs are strongly connected to economic aspects since sustainable practices can result in long-term cost savings, improved resource efficiency, and the creation of new economic opportunities.

2.3.4 Governance Aspects

The idea of SSC revolves around a city's or its government's capacity to innovate, provide clever solutions to local problems, and raise the standard of public services (Arief *et al.*, 2020). Likewise, the level of readiness for SSC should be measured not only by the technological aspects but also by the non-technological aspects like vision, policies, initiatives and governance (Achmad *et al.*, 2018). By combining mechanism reform with system innovation to meet a range of urban difficulties, the concept of SSC presents a new paradigm for urban government (Su, Miao and Wang, 2022). Additionally, to provide dependable, credible, and easily available public services that address community demands, the government must also use ICTs since the effectiveness of information systems is determined by their capacity to help organisations achieve their objectives (Antoni, Arpan and Supratman, 2020). Therefore, the readiness of the government is crucial, as only then will the transformation into a SSC be achievable.

Noori, De Jong and Hoppe (2020) stated that the governance style and the mindset of municipal administrators heavily influence the growth of SSCs in Tehran. Thus, the SSC projects in Tehran depend on well-coordinated laws, regulations, and plans (Noori, De Jong and Hoppe, 2020). In order to manage urban issues effectively and promote the growth of SSC, smart governance uses technology to improve cooperation between local governments and citizens (Tomor *et al.*, 2019). Tomor, *et al.* (2019) claimed that maintaining public satisfaction is crucial for establishing smart governance in SSC which can be achieved through continuous enhancement of e-participation initiatives with regular reporting and feedback loops. Furthermore, a strong top-down approach that prioritises government-implemented policies that adhere to societal benefits over environmental ones is credited with making Singapore a successful SSC (Cavada, Tight and Rogers, 2019).

2.4 Strategies to Improve City Readiness towards Smart Sustainable City

Improving city readiness towards SSC requires a strategic approach that covers several key areas. This includes public education and awareness, investment incentives and subsidies, infrastructure development, and strong policy and regulatory frameworks to support and sustain progress. A list of strategies to improve city readiness, as identified in previous studies, is summarised in Table 2.2.

Table 2.2: Previous Studies on Strategies to Improve City Readiness towards SSC

No.	Strategies to Improve City Readiness	Previous Studies
	Education and Awareness Campaigns	
1	Citizen Awareness and Participation	Alakavuk *et al.* (2023); Alamoudi, Abidoye and Lam (2022); Staletić *et al.* (2020); Rachmawati *et al.* (2023); Kamnuansilpa, *et al.* (2020)
2	Awareness Initiatives	Fan and Fan (2024); Kusumastuti and Rouli (2021); Nasrawi, Adams and El-Zaart (2016)
	Financial Incentives and Subsidies	
3	Monetary Incentives	Xu and Xu (2024); Vadgama *et al.* (2015); Sharon (2024)
4	Non-monetary Incentives	Wojewnik-Filipkowska and Węgrzyn (2019); Manca, *et al.* (2022); Bertolini (2020); Yoo (2021); Suwardi and Saad (2024)
	Infrastructure Development	
5	Internet and Connectivity Improvements	Khan *et al.* (2020); Ibrahim, El-Zaart and Adams (2018); Chang, Kadry and Krishnamoorthy (2020); Pompigna and Mauro (2022)
6	Public Transportation Enhancements	Hameed (2019); Khan *et al.* (2020); Makarova *et al.* (2017); Uchehara *et al.* (2022)
	Policy and Regulatory Frameworks	
7	Government's Role	Enwereji and Uwizeyimana (2022); Pereira and De Azambuja (2021); Noori, De Jong and Hoppe (2020); Chatfield and Reddick (2016)
8	Key Policies and Regulations	Pereira and De Azambuja (2021); Noori, De Jong and Hoppe (2020); Lima *et al.* (2020); Micozzi and Yigitcanlar (2022)
	Comprehensive Data Strategy	
9	Centralised Data Platform	Bibri (2017b); Vieira and Alvaro (2018)
10	Data Privacy and Ethics	Paskaleva *et al.*, (2017); Ismagilova *et al.* (2020); Ejjami (2024); Joyce and Javidroozi, 2024)
11	Data Analytics and AI	Kalusivalingam *et al.* (2021); Chavhan *et al.* (2024)

Table 2.2 (Continued)

No.	Strategies to Improve City Readiness	Previous Studies
	Pilot and Scale Smart Solutions	
12	Pilot Projects Implementation	Caragliu and Del Bo (2018); Woltering *et al.* (2019)
13	Scale Successful Projects	Bundgaard and Borrás (2021); Del Esposte *et al.* (2018)
14	Monitoring and Adaptation	Barrionuevo, Berrone and Costa (2012); Dikshit *et al.* (2023); Bittencourt *et al.* (2024)
	Plan for Long-Term Sustainability	
15	Integration of SSC Plans with Urban Planning	Bibri (2017a); Akaraci *et al.* (2016); Silva, Khan and Han (2018); Butler, Yigitcanlar and Alexander Paz (2020)
16	City's Resilience	Bianchi and Schmidt (2023); Sharifi, Khavarian-Garmsir and Kummitha (2021); Adenekan, Ezeigweneme and Chukwurah (2024); Kangana *et al.* (2024)
17	Adaptive Policies	Zhu, Li and Feng (2019)
	Secure Funding and Resources	
18	Diverse Funding Sources	Mirzaee and Majrouhi Sardroud (2022); Li *et al.* (2020); Laurance *et al.* (2015); Berrone *et al.* (2019)
19	Budget Allocation	Puron-Cid and Gil-Garcia (2022); Shah *et al.* (2021); Agboola and Tunay (2023)

2.4.1 Education and Awareness Campaigns

City residents are often left in the dark and denied meaningful involvement in sustainability studies and seminars carried out by several local governments, which are predominantly attended by professional stakeholders (Alakavuk *et al.*, 2023). Alakavuk *et al.* (2023) also claimed that the National Smart Cities Strategy and Action Plan highlighted the critical role that city residents play in urban development and the necessity of researching effective participation mechanisms in Turkey and throughout the world to improve or create new applications for SSC solutions in urban services. Khan *et al.* (2020) declared that most citizens are ignorant of the amenities and services offered by SSC, underscoring the necessity of raising citizen knowledge to fully maximise the benefits of a SSC. Besides, the reason for municipalities' failure to embrace the concept of SSC is not the technological capabilities, but rather the incapacity to raise public awareness of the advantages of SSC was reviewed by Enwereji and Uwizeyimana (2022). Alamoudi, Abidoye and Lam (2022) also mentioned that raising citizens' awareness and encouraging their participation helps integrate top-down and bottom-up urban planning and decision-making approaches, thereby swiftly enhancing the policies and governance of SSC. Hence, to transform to SSC, there is a critical need to raise public knowledge to improve their readiness towards the transformation.

Different forms of citizen e-participation have arisen in SSCs within the context of established IT such as China's legislative mandate for public engagement in urban planning since 2008 (Staletić *et al.*, 2020). Many people in North Penajam Paser are still ignorant about the SSC projects in Nusantara Capital City, Indonesia, indicating that the local community and authorities are still unaware of the notion of a SSC (Rachmawati *et al.*, 2023). Correspondingly, Kamnuansilpa *et al.* (2020) affirmed that the people of Khon Kaen would not be very aware of the SSC if there were no efficient information, education, and communication campaign. Consequently, evaluating public awareness and understanding of SSC is a necessary step toward both the acceptance and the success of SSC development, as citizen involvement is crucial to its success. (Kamnuansilpa *et al.*, 2020).

Awareness initiatives serve as a valuable supplement to formal education by providing focused knowledge and encouraging positive changes in community behaviour (Fan and Fan, 2024). Social networking services such as Facebook may be a useful tool for governments to increase public awareness about SSC and to enhance citizens' readiness for transformation. For instance, Sarpsborg, a city in Norway, aggressively engages with its citizens on Facebook by giving them frequent news updates and swiftly attending to their needs and inquiries (Kusumastuti and Rouli, 2021). Next, the Change Readiness Index (CRI) can be adopted to improve the readiness to transform to SSC. KPMG International Cooperative and Oxford Economics have created the CRI which evaluates the factors that define a nation's readiness for change (Nasrawi, Adams and El-Zaart, 2016). Nasrawi, Adams and El-Zaart (2016) also stated that the CRI adopts a forward-looking stance by identifying variables that affect a nation's capacity to maintain steady long-term growth and manage change by comparison to other indices that concentrate on historical performance.

2.4.2 Financial Incentives and Subsidies

Encouraging environmentally conscious civic behaviour through the design of systems that balance individual self-interest with sustainable actions is one of the best ways to create a SSC (Kahya *et al.*, 2021). Kahya *et al.* (2021) further claimed that major change can be fueled by incentives to achieve this like the Aspiration credit card and climate change governance through carbon trading. Xu and Xu (2024) suggested that financial incentives like lower energy bills during off-peak hours and innovative pricing, supported by Public-Private Partnerships (PPPs), can enhance citizen engagement and encourage energy savings through Demand Response (DR) initiatives. Apanavičienė and Shahrabani (2023) demonstrated that raising public consciousness through campaigns and offering incentives can actively engage individuals and bolster efforts toward transitioning to a circular economy. Thus, incentives may encourage citizen participation, thereby catalysing the city's readiness to transition towards SSC.

Incentives for promoting SSC initiatives can be classified into monetary and non-monetary categories. One of the monetary incentives will be subsidies. Government grants and subsidies, usually non-repayable monies, offer vital initial assistance to initiatives requiring large amounts of monetary assets (Vadgama *et al.*, 2015). Vadgama *et al.* (2015) compared China's and

India's urban infrastructure expenditures and subsidies to highlight the possible advantages of raising funding to support the development of SSC. In short, subsidies can be granted to companies, locals, or organisations that make investments in sustainable activities or infrastructure. For non-monetary incentives, collaborative initiatives such as PPPs serve as an example. The growth of SSCs depends heavily on PPPs, which are cooperative efforts between the public and private sectors that provide advantages with limited human resources (Wojewnik-Filipkowska and Węgrzyn, 2019).

In some European countries like London, a Digital Social Market (DSM) tool is an online platform that is designed as a smartphone application that encourages city dwellers to adopt sustainable practices (Manca *et al.*, 2022). Manca *et al.* (2022) further elaborated that it does this by providing non-cash rewards, such as redeemable tokens for local discounts or microdonations, and by displaying these tokens publicly for peer recognition. Under Horizon 2020, the European Commission and European Investment Bank launched the European Local Energy Assistance (ELENA) program, which makes cities and regions ready for sustainable energy projects by supporting project preparation, implementation, feasibility studies, and financing (Bertolini, 2020). In Korea, the addition of incentives like little rewards can be taken into consideration to guarantee that residents participate in both the gathering of ideas and opinions and the execution of smart city initiatives (Yoo, 2021). This result from a SSC relies on the intelligent contributions of its citizens and the government's effective involvement of these citizens in smart initiatives (Sameer *et al.*, 2023).

2.4.3 Infrastructure Development

A city's infrastructure is a network of interconnected utilities, fundamental buildings, and services that range from the smallest residential units to the major city structure and buildings that provide services like water supply, sewerage, and power (Soyinka *et al.*, 2016). Ibrahim, El-Zaart and Adams (2018) pointed out that city readiness encompasses the current capabilities of a city, including its physical, organisational, and digital infrastructures, along with the overall level of digital literacy among its residents. Besides, Khan *et al.* (2020) stated that the initial phase of SSC development focuses on establishing communication and network infrastructure, underpinned by the advancing technologies of ICT, IoT and big data analytics. In Iraq, the transformation of Basra into a SSC hinges on key goals, including the enhancement of infrastructure networks and the implementation of an intelligent transport system to modernise its transportation and traffic networks (Hameed, 2019). Moreover, Pakistan's sustainable city is centred on formulating and applying policies concerning public transit, nearby facilities, and open space (Khan *et al.*, 2020). All of this reinforced the crucial role that infrastructure plays in enhancing the readiness for transforming into a SSC.

A vital intellectual component of the SSC, the transport system integrates smart users, smart vehicles, and smart infrastructure to guarantee sustainability and safety (Makarova *et al.*, 2017). The importance of evaluating a city's readiness for change as an independent phase in the transformation process is emphasised by Ibrahim, El-Zaart and Adams (2018). This stage involves a detailed assessment of the present state of ICT-based infrastructure, non-ICT-based infrastructure, and any prior SSC projects (Ibrahim, El-Zaart and Adams, 2018). For instance, one of the ICT-based infrastructures is the Intelligent Traffic Management System (ITMS). In order to solve traffic congestion, waiting times, travel expenses, and air pollution, Chang, Kadry and Krishnamoorthy (2020) mentioned that an ITMS for SSC uses ML algorithms to anticipate the best routes. Implementing the ITMS will significantly boost the readiness for transforming into SSC by optimising traffic flow, reducing congestion, and enhancing urban mobility. For physical infrastructure, Uchehara *et al.* (2022) highlighted that roads and highways are integral to modern daily life and will be pivotal in the development of sustainable cities. With 31 highways and expressways now in use and numerous more planned or under development, Malaysia has one of the greatest highway infrastructures among developed countries (Sazali and Firdaus, 2019). Furthermore, transportation efficiency, safety, and clean energy usage by incorporating smart highways that integrate connected devices and IoT into current highways (Pompigna and Mauro, 2022). This would improve the city's readiness to turn into a SSC.

2.4.4 Policy and Regulatory Frameworks

Effective campaigns to raise public awareness and educate the community necessitate cooperation and collaboration among a diverse range of stakeholders (Fan and Fan, 2024). These include corporations, community organisations, government agencies, non-profits, and educational institutions. Enwereji and Uwizeyimana (2022) suggested that the government set aside sufficient funds to promote projects related to the readiness of city towards SSC. To achieve success in innovation within local government, it is necessary to consider several factors, including municipal policy, city administration, and technology and maintaining a balance between these dimensions is crucial (Pereira and De Azambuja, 2021). In cities like Dubai and Amsterdam, local governments lead the SSC transition by coordinating stakeholders, aligning visions, integrating with regional and national programs, attracting funds, and implementing the SSC policy (Noori, De Jong and Hoppe, 2020). Chatfield and Reddick (2016) claimed that it is essential for the government to undertake cross-sector collaboration activities aimed at improving environmental sustainability since SSC implementation is seen as a collaborative bottom-up intervention for social innovation and public policy implementation. By means of extensive planning and coordination, the government may provide an ideal environment for innovation, guaranteeing that enterprises, communities, and academic establishments are striving for the same objective.

A vital factor impacting city readiness is the policy environment, which includes national policies, legislation, and local governance frameworks (Noori, De Jong and Hoppe, 2020). Noori, De Jong and Hoppe (2020) further claimed that it is crucial to evaluate cities' readiness to execute SSC initiatives that are customised to their unique circumstances since the Iranian government places significant emphasis on globalisation and smart urban development in its policy documents. Thus, to effectively transition to SSC, key policies and regulations must be established to guide and support the transformation process. The City Statute, Brazil's main urban policy law, guides municipalities with sixteen guidelines to develop urban social functions, promoting environmental balance, collective goods, security and citizens' well-being, which supports SSC initiatives (Lima *et al.*, 2020). Moreover, Micozzi and Yigitcanlar (2022) highlighted that smart economy policies, being the most popular among SSC policy domains, focus on maintaining economic competitiveness by investing in SSC technologies to attract innovative businesses. Besides, Micozzi and Yigitcanlar (2022) stated various policy implementations related to 'smart mobility,' with transportation management as the most prominent issue, due to which smart mobility became the second most popular focus in SSC policies. This is due to the development of SSC has become a critical issue, with a primary focus on creating smart and sustainable transportation systems (Mavlutova *et al.*, 2023).

2.4.5 Comprehensive Data Strategy

Achieving SSC involves non-technical aspects, but from an ICT perspective, success depends on the interoperability of existing and future systems for effective data sharing and utilisation (Jeong, Kim and Kim, 2020). A SSC develops around an urban data platform that consolidates diverse data sources, including static data such as government and open data, alongside dynamic real-time data like sensor and IoT information (Tcholtchev and Schieferdecker, 2021). The basic centralised data processing platforms and data mining systems cannot computationally and analytically support data stored in various places across widespread dynamic contexts (Bibri, 2017b). Therefore, a well-established centralised data platform is crucial for enhancing citizen engagement and improving public administration. In 2011, Brazil's Delivering Information of Government (DIGO) project aimed to standardise governmental portals for better data disclosure, minimising conflicts and enabling citizens to create new applications (Vieira and Alvaro, 2018). Similarly, Vieira and Alvaro (2018) asserted that Catania, Italy, proposed a SSC data model that integrates various data domains to enhance citizen engagement and interaction with public administration. Overall, these examples illustrate the potential of centralised data platforms to foster collaboration and innovation in urban governance.

Privacy was commonly discussed in conjunction with concerns about data protection while considering organisational, regulatory, and policy hurdles (Paskaleva *et al.*, 2017). Ensuring data privacy and ethics is critical in SSC development because the massive amounts of data collected must be protected from misuse or breaches. For example, the IoT enables data collection from sensors and devices, necessitating a security framework to address stakeholder privacy concerns (Ismagilova *et al.,* 2020). Ensuring robust measures and maintaining public trust are crucial for the success of SSC initiatives, as these technologies must align with ethical standards to foster acceptance and benefit all urban residents (Ejjami, 2024). Thus, sophisticated knowledge of privacy, flexible policymaking tools, and a cooperative, adaptable regulatory framework that encourages innovation while guaranteeing data security are all necessary for managing data sharing in SSC (Joyce and Javidroozi, 2024).

The integration of Artificial Intelligence (AI), ML algorithms, and data analytics powered by the IoT offers the transformative potential to accelerate the progress of SSC initiatives (Kalusivalingam *et al.*, 2021). In a data-driven SSC, predictive models and AI algorithms can analyse big data to anticipate and address issues such as traffic congestion, pollution, and energy spikes. For example, this technology utilises AI to monitor traffic variations in the city, serving a dynamic and adaptive role in improving city life (Chavhan *et al.*, 2024).

2.4.6 Pilot and Scale Smart Solutions

Pilot and scale smart solutions are essential for testing and implementing innovative technologies in a manageable and effective way, ensuring their success before city-wide adoption. Since interventions are often carried out on a relatively small scale, small-scale integrated projects have a higher chance of success (Caragliu and Del Bo, 2018). On the other hand, scaling up SSC projects depends on effective collaboration among stakeholders, with equitable partnership and active engagement contributing to successful outcomes (Bundgaard and Borrás, 2021). Therefore, engaging stakeholders such as local governments, private entities, and residents ensures these solutions are tailored to specific urban needs and priorities.

Pilot projects are meant to test the feasibility and effectiveness of a solution to determine if it is worth expanding or scaling up over time (Woltering *et al.*, 2019). Once these projects demonstrate success, they can be replicated and expanded across the city, with adaptations to meet the unique needs of different areas. Del Esposte *et al.* (2018) stated that the ability of a platform to handle thousands of user requests and service operations highlights the varying scalability demands, shaped by the city’s unique characteristics and the applications deployed. However, significant deployment and usage challenges, combined with inadequate evaluation techniques, often hinder the effective scaling and performance of such platforms (Del Esposte *et al.*, 2018). Therefore, regular evaluation is critical to ensure the long-term success of scaled SSC solutions. Barrionuevo, Berrone and Costa (2012) asserted that the city authorities must involve local residents, especially those most affected, by genuinely considering their ideas and opinions, even if unpopular. Feedback from residents, stakeholders, and city officials helps identify areas for improvement, while technological advancement enables upgrades to existing systems. For example, AI techniques can be enhanced, merged with emerging technologies like autonomous vehicles, and incorporated into comprehensive urban mobility frameworks (Dikshit *et al.*, 2023). Moreover, continuous adaptation ensures that SSC initiatives remain relevant and responsive to environmental changes and citizens' needs (Bittencourt *et al.*, 2024).

2.4.7 Planning for Long-Term Sustainability

The term "smart city" refers to a wide range of techniques and policies intended to improve long-term sustainability, public service delivery and management, and urban life quality (Barrionuevo, Berrone and Costa, 2012). These principles serve as a foundation for integrating SSC plans with urban planning. Bibri (2017a) proposed creating a framework combining smart city and sustainable city concepts to address current challenges and align solutions for future urban planning and development practices. Although the primary focus of SSC is technology, urban and regional planning principles still apply (Akaraci *et al.*, 2016). This suggests that technology should be embedded into urban development strategies. By doing so, the city can address challenges like population growth, traffic congestion, excessive urbanisation, etc (Silva, Khan and Han, 2018). For example, most vehicles' fuel efficiency would rise if smart mobility advances were used to reduce traffic (Butler, Yigitcanlar and Alexander Paz, 2020). This, in turn, contributes to achieving long-term urban growth objectives by promoting sustainability and reducing resource consumption.

When developing a SSC, resilience and adaptability are also essential. SSCs must adopt innovative technologies and strategies to withstand environmental, economic, and social challenges and respond effectively to crises (Bianchi and Schmidt, 2023). Besides, resilience is approached more dynamically in other domains, such as those that deal with social and ecological elements and processes, and thus place greater emphasis on the ability to "adapt" (Sharifi, Khavarian-Garmsir and Kummitha, 2021). For example, prioritising social cohesion and community involvement by adopting bottom-up governance models that empower communities and grassroots organisations to actively shape smart city initiatives, fostering innovation and inclusivity (Adenekan, Ezeigweneme and Chukwurah, 2024; Kangana *et al.*, 2024). This ensures all urban residents benefit from SSC advancements. Apart from that, the correlation between smartness and resilience serves as a guide for enhancing resilience in SSC and shaping policies and measurements to improve it (Zhu, Li and Feng, 2019). It highlighted the importance of creating adaptive policies to ensure SSC initiatives remain relevant as technologies and urban needs evolve.

2.4.8 Secure Funding and Resources

Smart services, sustainable goals, and urban life quality depend on cities' financial capabilities and technological frameworks, with investments driving economic and environmental sustainability (Hedegaard *et al.*, 2024). In other words, securing funding and resources is a crucial strategy for increasing city readiness towards SSC. Diverse funding sources, such as government grants, private investments, international collaborations, and PPPs, provide the financial support necessary to develop and implement SSC initiatives (Mirzaee and Majrouhi Sardroud, 2022). Government grants often serve as foundational funding for large-scale infrastructure projects, while private investments bring additional capital and expertise (Li *et al.*, 2020; Laurance *et al.*, 2015). For PPPs, they particularly valuable as they enable cost-effective and cost-saving solutions (Berrone *et al.*, 2019). This diversified approach reduces dependency on a single source, ensuring resilience against financial uncertainties.

Moreover, SSC initiatives require significant investments and budget allocations to secure essential resources like personnel, materials, and ICTs for implementation (Puron-Cid and Gil-Garcia, 2022). This will further enhance readiness by prioritising high-impact projects that align with long-term sustainability goals. Besides, prioritising initiatives such as smart transportation ensures that funds are used effectively to address critical urban challenges, with transportation being a key focus to achieve sustainability goals in urban areas (Shah *et al.*, 2021). This balance allows cities to remain adaptable to evolving technological, social, and environmental needs, ensuring that resources are used responsibly and effectively to build a sustainable and future-ready urban environment (Agboola and Tunay, 2023). This comprehensive approach to securing and managing resources is crucial for fostering innovation and building a smart, sustainable urban future.

2.5 The Effect of Sociodemographic Factors on City Readiness towards Smart Sustainable City

This research aims to investigate the connection between the sociodemographics of citizens and city readiness. SSC aims to enhance daily life practices in urban areas, and thus, the effective and smart involvement of citizens in city planning is a crucial precondition for the successful transformation of SSC (Beştepe and Yildirim, 2022; Sameer *et al.*, 2023). The findings will enable an assessment of how various social demographic factors influence the city's readiness to adopt this technological transformation. Numerous studies on technological acceptability focus on the effects of demographics, particularly age, gender, and education (Beştepe and Yildirim, 2022).

Different sociodemographic groups hold diverse views about the priorities and benefits of SSC initiatives, impacting how cities approach their readiness strategies. For instance, different generations will demonstrate varying levels of awareness towards SSC transformation. This is attributed to information creation activities, younger generations and older generations differ from one another (Shin, Kim and Chun, 2021). SSC has to incorporate digital participatory planning (DPP), which allows the general public to work with the government to make wise decisions together (Sameer *et al.*, 2023). Sameer *et al.* (2023) further claimed that middle-aged individuals tend to perceive themselves as more prepared and willing to participate in DPP than younger and older people. Furthermore, according to Biresselioglu, Demir and Altinci (2022), younger groups show a higher awareness of smart energy systems compared to older groups. Cities with younger populations may experience stronger advocacy for smart energy adoption, reflecting the distinct priorities of this demographic. Wawer, Grzesiuk and Jegorow (2022) reviewed that young people are more likely to value and support sustainable public transportation, demonstrating a connection between generational characteristics and readiness for smart mobility initiatives.

Apart from that, gender also influences perspectives on city readiness towards SSC (Alderete, 2021). Among genders, women typically exhibit greater caution and hold higher expectations than men before adopting SSC services (Huang *et al.*, 2022). Shin, Kim and Chun (2021) obtained that due to their less exposure to computer usage and lack of computer-related motives, women tend to have more unfavourable views regarding ICT use than men. Similarly, Alderete (2021) asserted that men were positively correlated with greater usage intention. Sameer *et al.* (2023) also stated that male employees generally express greater trust in authorities and higher willingness to collaborate, potentially indicating differing levels of confidence in SSC initiatives across genders.

Educational attainment plays a significant role in shaping perspectives on city readiness. People with higher levels of education tend to accept new technology more swiftly than those with lower levels of education (Hargittai, 1999). This may due to they tend to perceive the benefits of these systems more clearly. A greater degree of education raises the likelihood of ICT use since better-educated people are more likely to be aware of the advantages of SSC and have the capacity to act intelligently, which promotes the growth of SSC activities (Alderete, 2021). Barachi *et al.* (2022) claimed that the respondents were comparatively tech-savvy, considering they held bachelor’s or master’s degrees. Cities with higher levels of educated populations may benefit from stronger advocacy for SSC policies, as these groups often have more confidence in technology-driven urban solutions. Sameer *et al.* (2023) asserted that the residents with lower educational levels are more likely to be concerned about their privacy in the digital sphere and less confident in the participation concept. Biresselioglu, Demir and Altinci (2022) also demonstrated that populations with lower education levels may exhibit scepticism toward intelligent environmental technologies, potentially hindering progress in SSC adoption.

On the other hand, different income levels influence people’s attitudes toward the SSC transformation. Higher-income groups may perceive SSC initiatives as beneficial for economic growth and environmental sustainability, while lower-income groups may focus on affordability and accessibility. In addition to economic considerations like income influencing preference and consumption patterns, smart energy technologies are sensitive to user participation and trust (Biresselioglu, Demir and Altinci, 2022). Biresselioglu, Demir and Altinci (2022) further claimed that higher-income citizens are more likely to believe that people would support energy-saving measures on their own and have higher confidence in society overall. Shayan and Kim (2023) discussed that the recent study also discovered that those with lower and intermediate incomes are more vulnerable to social exclusion if they are unable to make good use of SSC solutions. Moreover, citizens with middle-range monthly incomes tended not to participate at high levels which showed an inverse relationship with high participation likelihood (Panyavaranant *et al.*, 2023).

Apart from that, marital status influences perspectives on city readiness towards SSC as it shapes priorities and expectations. Studies have shown that married respondents exhibit significantly higher levels of SSC literacy compared to non-married individuals, while the results for divorced populations were not statistically significant (Lee, Kang and Kim, 2024). This may be attributed to their higher SSC literacy, making married individuals more aware of and supportive of sustainability initiatives that align with family-oriented needs. However, individual experiences vary, and marital status alone does not determine one's ability to engage with the community or public life (Alamoudi, Abidoye and Lam, 2023).

Ethnicity plays a significant role in shaping how communities engage with and perceive the development of SSC, particularly in multicultural societies such as Malaysia and Singapore, where Chinese, Malay, and Indian populations are prominent. However, ethnic and racial discrimination remains prevalent in many such societies, which can pose challenges to SSC development by limiting equal participation and access to opportunities (Okafor, Aigbavboa and Thwala, 2022). These barriers may result in varying levels of trust, engagement, and openness to SSC initiatives among different groups. For instance, Chinese Malaysians exhibit the highest acceptance of SSC concepts, with approximately 75% expressing positive attitudes, possibly due to higher educational attainment and economic prosperity within the community, which enhances awareness of and receptivity to technological advancements (Noor *et al.*, 2024). In contrast, Malays are more likely to actively utilise urban public spaces than their Chinese and Indian counterparts (Elfartas, Albeera and Jibri, 2022), suggesting that SSC designs emphasising such spaces may resonate more with the Malay community. However, ethnic disparities persist as 62% of Indians and 57% of Chinese in Malaysia report feeling unfairly treated (Loheswar, 2024), which can erode trust and reduce participation in SSC projects. Kontokosta and Hong (2020) further noted that racial groups and foreign-born residents are often less likely to report concerns due to limited engagement in political processes. Together, these findings highlight how ethnicity and racial experiences critically shape the perception, participation, and ultimately, the success of SSC development across diverse communities.

Furthermore, the geographical area may also influence the readiness and implementation of SSC initiatives. The average population with these characteristics is probably less likely to utilise ICT in these faraway areas than it is in cities (Shin, Kim and Chun, 2021). On the contrary, Panyavaranant *et al.* (2023) declared that the peri-urban citizens in Thailand will have high participation behaviour. Urban and peri-urban populations may differ in their expectations of SSC benefits, leading to varied levels of readiness across geographical regions. In addition, citizens in SSCs, like Putrajaya, may have a different perspective on city readiness compared to those in cities still transitioning, such as Kuala Lumpur. Putrajaya, designed as a smart garden city with green spaces and integrated infrastructure (Lim, Woods, & Koo, 2023), offers residents firsthand experience of SSC principles. In contrast, Kuala Lumpur, still implementing its Smart City Master Plan 2021–2025, means its citizens may have a more cautious view of city readiness towards SSC (Talib & Muhammad Taib, 2024). This difference in exposure likely shapes how residents perceive and engage with SSC initiatives.

Last but not least, citizens with or without income may have different perspectives on city readiness, as their circumstances shape their engagement and expectations. Alam and Siddiqui (2021) suggest that unemployed individuals often view SSCs as opportunities for skill development and potential employment, motivating them to participate in initiatives that could enhance both personal and community advancement, particularly when policies are inclusive and participatory. Similarly, students with higher computer proficiency are better positioned to benefit from SSC developments, with their perceptions of such initiatives closely tied to their comfort and familiarity with digital tools and environments (Picatoste *et al.*, 2017). This indicates that citizens' employment status and digital competencies influence their engagement with SSC initiatives.

2.6 Summary of Findings from Literature Review

Figure 2.1 presents the research conceptual framework, illustrating that the transformation of cities into SSCs may occur at varying levels of readiness. These readiness levels differ across sociodemographic groups, such as age, gender, and ethnicity. By assessing both the overall readiness level and the influence of these sociodemographic factors, more targeted strategies can be developed to enhance city readiness towards SSC in an inclusive and equitable manner.

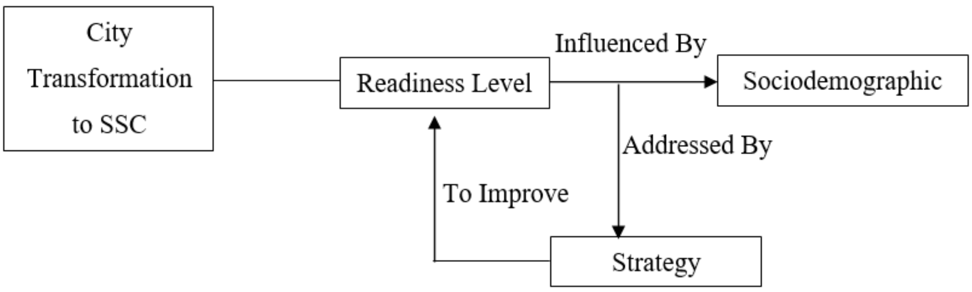

Figure 2.1: Research Conceptual Framework

Figure 2.2 provides an overview of the findings from the literature review. This overview comprises the criteria for measuring the city readiness, the strategies to improve the city readiness towards SSC and the effect of sociodemographic factors on city readiness. The city readiness level are measured based on several aspects, namely human aspects, technology aspects, economic aspects, and governance aspects and the strategies proposed will improve the city readiness including education and awareness campaigns, financial incentives and subsidies, infrastructure development, policy and regulatory frameworks, comprehensive data strategy, pilot and scale smart solutions, planning for long-term sustainability, and secure funding and resources. Additionally, it is essential to consider the sociodemographics of the citizens such as age, gender, educational level, income level, marital status, ethnicity, geographical location, and type of income as different sociodemographic groups may have varying perspectives and priorities, leading to differences in their views on city readiness. Figure 2.1 underscores the importance of aligning these criteria and strategies to effectively achieve city readiness, ensuring a holistic approach to SSC development.

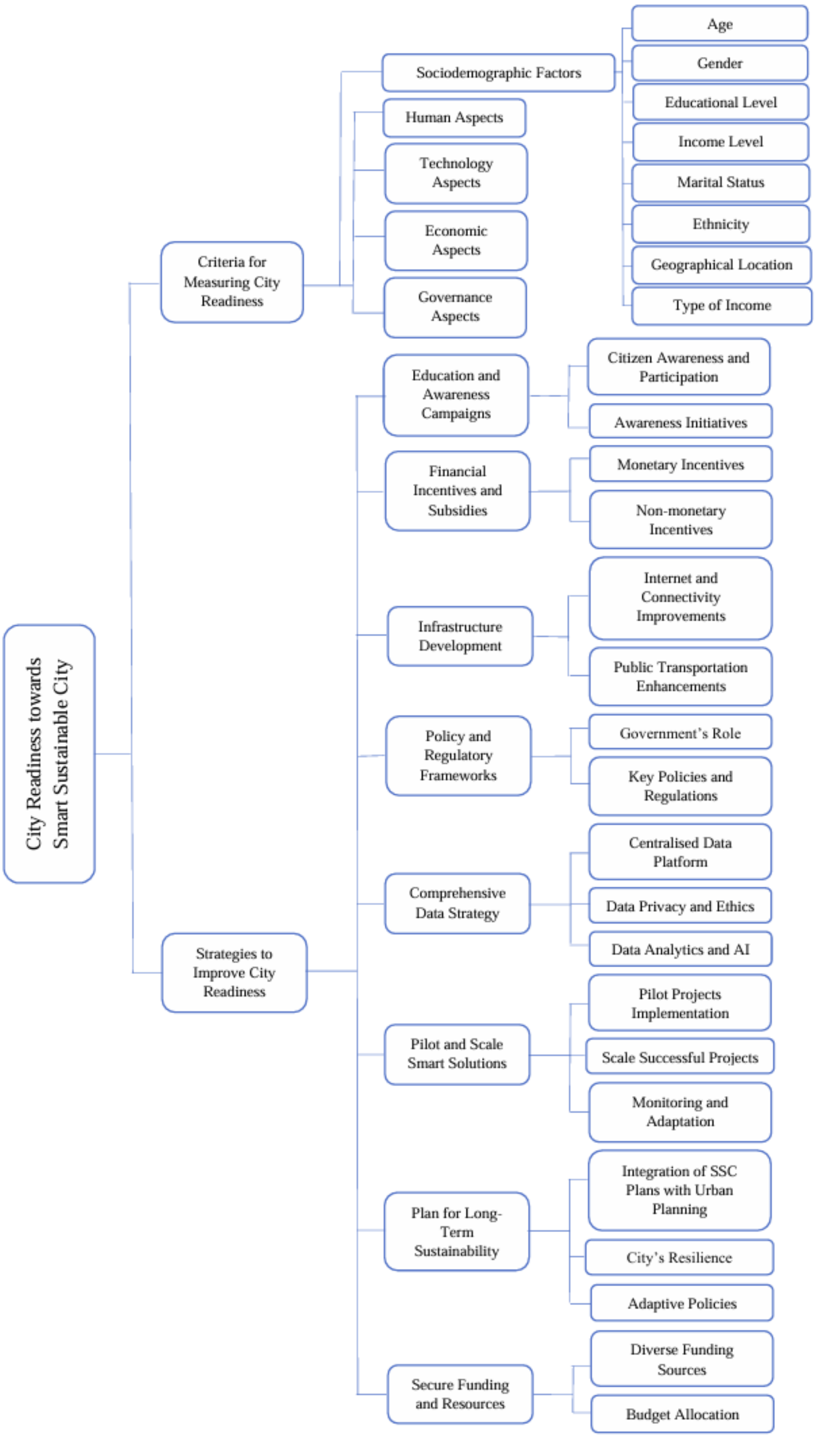

Figure 2.2: Summary of Findings from Literature Review

2.7 Summary of Chapter

In summary, this chapter initially detailed the definition, concept of SSC and a comparison of SSCs between Malaysia and other countries. Criteria for measuring city readiness towards SSC were subsequently discussed in the next section. In addition, the strategies that can be adopted to improve the city readiness were presented. Next, the effect of sociodemographic factors on the city readiness was reviewed. This chapter concluded with a research conceptual framework and summary of the literature review findings on city readiness towards SSC, highlighting the criteria for assessment and strategies for improvement.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

This chapter details the research methodology, data collection procedures, and analytical tools used to achieve the objectives. It presents a comparison of qualitative and quantitative methods, followed by the justification for the chosen approach. The research process, including literature review, data collection, questionnaire design, sampling determination, and data analysis, is outlined. Lastly, a summary concludes the chapter.

3.2 Research Method

Research is the process of defining or abandoning certain assertions in favour of others that are more solidly supported is the process of conducting research (Creswell, 2008). Cooper and Schindler (2014) spelt out that research is an organised inquiry that is carried out to yield data for problem-solving; it includes reporting as well as descriptive, explanatory, and predictive investigations.

3.2.1 Quantitative Research Approach

Quantitative research is defined as the process of testing objective hypotheses by looking at correlations between variables that are measured and statistically evaluated (Creswell, 2014). It is particularly advantageous when collecting on a wide scale is necessary. Precise measurement of variables like customer's behaviour, knowledge, views, or attitudes is the primary objective of quantitative research (Cooper and Schindler, 2014). Overall, quantitative research provides a structured approach to data collection and analysis, enabling objective evaluation and generalization of findings.

There are several benefits to adopting a quantitative research method, including its ability to provide objective, measurable, and generalisable data. Quantitative research results can be applied to a broader population or a specific subgroup because the study uses a large, randomly selected sample (Rahman, 2016). Besides, the planning phase of quantitative research, which comes before and is separate from data collecting and analysis, involves the identification of variables and their conversion into specific tasks (Neuman, 2014). Planning and defining variables before data collection ensures a structured and systematic approach, leading to more consistent and replicable results. In contrast, there are several shortcomings with this approach. In extensive quantitative studies, the researcher who interprets the data and makes inferences from it is frequently not the one collecting the data and usually does not interact with the participants at all (Cooper and Schindler, 2014). The lack of direct contact between the researcher and participants can lead to a disconnection form the context of the data, potentially limiting the depth of interpretation.

3.2.2 Qualitative Research Approach

Creswell (2008) defined the qualitative research approach as a method for investigating and comprehending the meaning that individuals or groups assign to a social or human challenge. Creswell and Creswell (2018) highlighted the importance of describing the complexity of a situation, recognizing an inductive method of inquiry, and putting a priority on special meaning to them. This approach often involves collecting non-numerical data, such as interviws, observations, and textual analysis. The aim of qualitative research is to fully comprehend a situation (Cooper and Schindler, 2014). Therefore, qualitative research is valuable for exploring complex issues, developing theories, and capturing the richness of human experiences.

The use of a qualitative research approach provides several advantages. One key strength is that smaller sample sizes enable quicker results, making it particularly useful for fast, low-risk decision-making (Cooper and Schindler, 2014). Additionally, Creswell and Creswell (2018) highlighted that qualitative research employs diverse designs, unique data processing methods, and a mix of text and image data. These elements help capture in-depth, context-specific insights that more structured approaches might overlook. However, a significant limitation is that smaller sample sizes raise concerns about the generalizability of findings to the broader population (Rahman, 2016). Since qualitative research focuses on an in-depth analysis of specific cases, the insights gained may not be applicable to other contexts or populations, reducing the study's overall impact. Neuman (2014) further noted that qualitative research retains data in various nonstandard formats rather than converting all observations into a uniform numerical medium.

3.3 Justification of Selection

The quantitative research approach was chosen due to it aligns with the study's objectives. For this study, the main purpose is to assess the city readiness towards SSC in Malaysia. A quantitative research method was adopted to systematically assess the readiness indicators through numerical data. A large group of respondents is required to generate comprehensive data on the opinions of citizens regarding city readiness. This approach is particularly important because sociodemographic factors significantly influence perceptions of city readiness and a sizable sample ensures that these factors are accurately represented. Survey research was chosen since questionnaires could be sent in a short period of time to a high number of targeted respondents. The results will be more consistent and trustworthy if statistical software and scientific methodologies are used to interpret the data that has been gathered. As such, a vast amount of data may be gathered and examined more quickly.

On the other hand, the qualitative research approach was not chosen for this study due to its limitations in handling large sample sizes and its inherently time-consuming nature. Qualitative research typically involves detailed data collection methods such as in-depth interviews, focus groups, and participant observations, which require significant time for conducting, transcribing, and analysing. In addition, the qualitative research approach is less desirable for this study on city readiness towards SSC, as it typically concentrates on data interpretations based on individual opinions, perceptions, and understandings. This focus may not capture the broad, quantifiable insights needed to assess readiness comprehensively across a diverse population. Moreover, one individual's perception of readiness cannot accurately represent the readiness levels of the entire citizen population. Therefore, the quantitative research approach is applicable to gauge and compare the readiness across the broader population.

3.4 Literature Review

Literature review is defined as selecting and critically assessing existing documents on a subject to achieve specific goals, convey opinions, and guide the investigation of the topic (Sekaran and Bougie, 2016). A basis of a study is provided by corporate statistics, industry reports, or current research papers, all of which are examined in the literature review part (Cooper and Schindler, 2014). Consequently, the literature review plays a crucial role in identifying research opportunities and shaping the direction of the study.

The literature review was conducted in six steps in this study. The first step involved identifying keywords to effectively locate relevant materials in an academic library. The relevant keywords identified for this study included “smart sustainable city”, “city readiness”, “city readiness towards Smart Sustainable City”, and “strategies to improve city readiness towards smart sustainable city”. The second step was finding relevant literature by looking through a number of publications and databases pertaining to the study topic. Most of the publications and articles for this study were obtained from Science Direct, Google Scholar, and Research Gate. Evaluating and synthesising relevant literature for the focus of the study constitutes the third step. When conducting a literature review, a gap in the understanding of the field was found by carefully examining the knowledge domains from earlier studies. In the end, a literature review was written to emphasise the criteria for measuring the city readiness towards SSC as well as the strategies to improve the city readiness. Figure 2.1 demonstrates the criteria for measuring city readiness, strategies to improve city readiness and the effect of sociodemographic factors on city readiness.

3.5 Quantitative Data Collection

The survey strategy was selected for this study to efficiently and economically collect quantitative data with greater accuracy and less subjectivity. A questionnaire, being a familiar method for respondents, was used to effectively survey large populations and gather primary data, aligning with the need for statistical results from a large sample (Creswell and Creswell, 2018; Sekaran and Bougie, 2016). The following section provides a detailed overview of the design of questionnaire, sampling process, and distribution methods.

3.5.1 Questionnaire Design

Table 3.1 outlines the design of the questionnaire. The cover page of the questionnaire contained the personal information of the researcher along with a brief questionnaire introduction. The questionnaire was structured into Sections A, B, and C with all questions being closed-ended. Section A was aimed at collecting sociodemographic information from respondents to fulfil the third objective, asking them to indicate their gender, age group, income level, education level, marital status, ethnicity, type of income, and the region they lived in.

In Section B, the respondents were required to evaluate and rank the city readiness towards SSC based on their residing city by looking into the criteria for measuring city readiness. This section was designed to achieve the first objective of this study. Five-point Likert scale was adopted in this section, from 1 = strongly disagree, to 2 = disagree, to 3 = neither agree nor disagree, to 4 = agree, to 5 = strongly agree. For Section C, it mainly designed to view the perspective of respondents pertaining to the strategies to improve the city readiness. A sample of the questionnaire survey is provided in the Appendix.

Table 3.1: Summary of Quationnaire's Design

Section	A	B	C
Section Title	Demographic Section	Readiness Level of Cities for Becoming SSCs	Strategies to Improve City Readiness towards SSC
Type of Question	Multiple Choice Questions	5-point Likert scale	5-point Likert scale
Number of Questions	9	21	37
Scale	Nominal Scale	Ordinal Scale	Ordinal Scale
Purpose of Questions	To obtain demographic information of the respondents	To meet objective 1	To meet objective 2

3.5.2 Sampling Determination

The fundamental concept of sampling is that by selecting a subset of elements from a population which can make inferences about the entire population (Cooper and Schindler, 2014). A well-chosen sample ensures that the study results are reflective of the larger group, reducing the need for a full population survey. Besides, Saunders, Lewis and Thornhill (2016) argued that sampling can achieve greater overall accuracy compared to conducting a census. In other words, by carefully determining the sample size and selecting appropriate sampling methods, the reliability and generalisability of the research findings can be enhanced.

Sampling methods are generally categorised into probability and non-probability techniques. Probability sampling is widely used in survey research to draw inferences about a population, ensuring the study addresses research questions and objectives (Saunders, Lewis and Thornhill, 2016). Non-probability sampling, which does not provide a predetermined chance of selection, is frequently used in research (Sekaran and Bougie, 2016). In this study, non-probability sampling was chosen. Convenience sampling, which is a non-probability method, was employed to enhance response rates from a diverse demographic. Convenience sampling was carried out by distributing the questionnaire through Google Forms, which was shared using various channels, including social media platforms, email, and personal networks. The survey link was also circulated through friends and family, who further helped in reaching a broader group of respondents by sharing the form within their own networks. This approach facilitates the recruitment of a large number of easily accessible respondents by prioritising ease of access and availability.

Next, the Cochran formula is adopted to determine the sample size. The Cochran formula is:

$$n = \frac{z^2pq}{e^2}$$

Where,

n = sample size

z = the z-scores at 95% confidence level, 1.96

p = the proportion of the population with attributes understudy, (2,914,303/32,447,385) = 0.09

q = 1 – p

e = margin of error, 5%

$$n = \frac{1.96^2(0.09)(1-0.09)}{0.05^2} = 126$$

Asenahabi and Ikoha (2023) asserted that, in most cases, the margin of error was plus or minus 5%, with a confidence level of 95%, corresponding to a z-score of 1.96. This ensures that the results are statistically reliable and can be generalised to the broader population with minimal error. According to Department of Statistics Malaysia (2023), the population of Malaysia is 32,447,385, while the population of Shah Alam, Kuala Lumpur, Putrajaya and Cyberjaya is 2,914,303. Accordingly, the Cochran formula indicates that a minimum sample size of one hundred and twenty-six is needed to achieve an acceptable level of accuracy.

In addition, the sample is calculated using the Central Limit Theorem (CLT). The CLT stated that for sufficiently large sample sizes, the distribution of sample means will approximate a normal distribution centred around the population mean (Cooper and Schindler, 2014). By leveraging the CLT, researchers can apply statistical techniques that assume normality, which simplifies analysis and increases the reliability of their conclusions. This makes the CLT a cornerstone in statistical practice, especially when dealing with large samples.

3.5.3 Questionnaire Distribution

After determining the sample and designing the questionnaire, it was created by using Google Forms and distributed electronically to residents of Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam via email and social media platforms including WhatsApp, Instagram, Microsoft Teams, and LinkedIn. To reach these specific areas, targeted outreach was conducted through community groups, local forums, and social media pages relevant to each city. This approach aimed to engage a diverse range of respondents from the targeted regions while ensuring broad participation across the selected area. The distribution of the questionnaire and the data collection from participants were completed over a span of approximately six weeks.

3.6 Data Analysis

The analysis of data was performed using the Statistical Package for the Social Sciences (SPSS) following the completion of data collection. Five statistical tests were utilised for data analysis, including Cronbach's Alpha Reliability Test, Arithmetic Mean, Spearman's Correlation Test, Kruskal-Wallis Test, and Mann-Whitney U Test.

3.6.1 Cronbach's Alpha Reliability Test

Cronbach's Alpha Reliability Test measures the internal consistency or reliability of multiple items in a questionnaire, indicating how stable and reliable the responses or ratings are. The average correlation between each item on the scale is shown by this statistic, which has values ranging from 0 to 1, with large values denoting stronger reliability (Pallant, 2005). Alpha, derived from a correlation matrix, is interpreted similarly to other reliability metrics. The alpha should be positive and typically exceed .70 to demonstrate strong internal consistency reliability (Morgan *et al.*, 2011). Besides, Pallant (2005) indicated that the Cronbach alpha coefficient should ideally be more than .7, however due to item sensitivity, it may be lower for short scales with less than 10 items. Sekaran and Bougie (2016) also stated that reliability scores below 0.60 are considered poor, those around 0.70 are deemed acceptable, and scores exceeding 0.80 are regarded as good. Therefore, this research utilizes this method to assess the consistency and reliability of Sections B and C in the questionnaire survey.

3.6.2 Arithmetic Mean

The arithmetic mean, often referred to as the mean, is a common measure of central tendency obtained by adding all numerical values in a dataset and dividing the total by the number of observations (Brase and Brase, 2009). In this study, the arithmetic mean was used to assess the average readiness level of SSCs and non-SSCs and the strategies to improve city readiness level. While the data gathered from 5-point Likert scale questions was interval-scaled, responses were divided into three categories including low, moderate, and high levels of readiness and effectiveness of strategies as shown in Table 3.2 (Pimentel, 2010). The study ensured that intervals were consistent across categories, resulting in a uniform distribution of differences (Nyutu, Cobern, and Pleasants, 2021).

Table 3.2: Scale to Measure Level of Readiness and Effectiveness (Pimentel, 2010)

Level of Readiness	Interval
Low	1.00-2.33
Moderate	2.34-3.67
High	3.68-5.00

3.6.3 Spearman's Correlation Test

Spearman’s correlation test is a non-parametric statistical method used to measure the strength and direction of the relationship between two ranked variables. In other words, this test is suitable for analysing relationships between variables measured on an ordinal scale (Sekaran and Bougie, 2016).

Normally, the correlation coefficient ranges from -1 to +1, with a value of 0 indicating no correlation and values closer to 1 representing a stronger correlation, where 1 signifies a complete correlation (Alsaqr, 2021). The value ranges from -1, indicating a simple and linear negative relationship, to +1, representing a simple and linear positive relationship (Abd Al-Hameed, 2022). In this study, this test was used to determine the strength of the correlation between the city readiness towards SSC and strategies to improve the city readiness.

3.6.4 Kruskal-Wallis Test

The Kruskal-Wallis Test was used to compare independent groups or conditions with more than two variables (Field, 2018). The Kruskal-Wallis Test was used to analyse variations in city readiness across different sociodemographic factors, with “age”, “income level”, “education level”, and “ethnicity” serving as the independent variables.

To test the hypothesis, the H-value was compared to the critical Chi-square value. The null hypothesis (H_0) is discarded if the critical Chi-square value is lower than the H-value; however, if the critical Chi-square value is higher, the null hypothesis is not rejected. To identify significant differences between sociodemographic profiles, both the null hypothesis (H_0) and alternative hypothesis (H_1) were formulated,

Null hypothesis (H_0): There is no significant difference across the age/income level/education level/ethnicity of the residents on the city readiness.

Alternative hypothesis (H_1): There is a significant difference across the age/income level/education level/ethnicity of the residents on the city readiness.

3.6.5 Mann-Whitney U Test

When comparing the continuous measure median of two independent groups, the Mann-Whitney U Test is utilised as a non-parametric substitute for the t-test (Pallant, 2005). In this study, this test evaluated the data from respondents in Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam to examine how different sociodemographic factors influence city readiness.

In this research, the dependent variable is “criteria affecting the city readiness towards SSC”, while the demographic profiles of residents staying in Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam including “gender”, “marital status”, “residential state”, and “type of income”, serve as the independent variables. To examine the differences between independent and dependent variables, the null hypothesis (H_0) and alternative hypothesis (H_1) were formulated as below:

Null hypothesis (H_0): There is no significant difference across the gender/marital status/residential state/type of income of the residents on the city readiness.

Alternative hypothesis (H_1): There is a significant difference across the gender/marital status/residential state/type of income of the residents on the city readiness.

3.7 Summary of Chapter

In summary, this study employed the quantitative method to meet the research aim and objectives, chosen for its efficiency in data collection within a short period. To gather the primary data, a questionnaire survey was created and sent by email and social media to the targeted respondents. To determine the sample size, the Cochran method and CLT were applied. Besides, the convenience sampling was used to assemble the respondents for this study. The statistical analyses included Cronbach's Alpha Reliability Test, Arithmetic Mean, Spearman's Correlation Test, Kruskal-Wallis Test, and Mann-Whitney U Test.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents and analyses the questionnaire data. It begins with a summary of respondents' demographics, followed by a Cronbach's Alpha Reliability Test to assess the data's reliability. The Arithmetic Means of SSCs and non-SSCs readiness levels and improvement strategies are then ranked. Next, Spearman's Correlation test is adopted to examine the relationship between the readiness levels and strategies. The Kruskal-Wallis Test was used to identify the significant differences between the age groups, income levels, educational levels, and ethnicity, while the Mann-Whitney U Test was applied to determine the significant difference in the readiness level between gender, marital status, residential state, and type of income.

4.2 Demographic Background of Respondents

Through the distribution of questionnaire surveys, 113 responses in all have been collected. After filtering out the responses from other cities and below 20 years old that were out of the scope of Putrajaya, Cyberjaya, Kuala Lumpur, and Shah Alam, the remaining 100 sets of responses were used for analysis. The respondents' demographic background is shown in Table 4.1.

Table 4.1: Demographic Profile

Demographic Data	Frequency (N)	Percentage (%)
Gender		
Male	53	53.0%
Female	47	47.0%
Age Group		
21-30 years old	53	53.0%
31-40 years old	25	25.0%
41-50 years old	16	16.0%
51-60 years old	6	6.0%

Table 4.1 (Continued)

Demographic Data	Frequency (N)	Percentage (%)
Highest Educational Level		
High School	4	4.0%
Sijil Pelajaran Malaysia (SPM) / GCE O-Level / equivalent	3	3.0%
Sijil Tinggi Persekolahan Malaysia (STPM) / GCE A-Level / equivalent	1	1.0%
Foundation	2	2.0%
Diploma	25	25.0%
Bachelor’s Degree	56	56.0%
Master’s Degree	9	9.0%
Income Level		
B40	61	61.0%
M40	34	34.0%
T20	5	5.0%
Marital Status		
Single	62	62.0%
Married	36	36.0%
Divorced	1	1.0%
Separated	1	1.0%
Residential State		
Kuala Lumpur	35	35.0%
Putrajaya	25	25.0%
Cyberjaya	21	21.0%
Shah Alam	19	19.0%
Ethnicity		
Malay	28	28.0%
Chinese	55	55.0%
Indian	17	17.0%

Table 4.1 (Continued)

Demographic Data	Frequency (N)	Percentage (%)
Occupation		
Student	34	34.0%
Employed (Full-time)	53	53.0%
Employed (Part-time)	1	1.0%
Self-employed	9	9.0%
Retired	2	2.0%
Others	1	1.0%

As shown in Table 4.1, respondent frequencies and percentages for each demographic profile are presented. There are 53.0% male respondents and 47.0% female respondents. Additionally, 53.0% of the respondents are between the ages of 21 and 30, while 25.0% are between the ages of 31 and 40. The age groups of 41–50 and 51–60 years old account for 16.0% and 6.0% of the respondents, respectively. Regarding the highest education level, the majority of respondents hold a bachelor's degree (56.0%), with diploma holders accounting for 25.0%. Furthermore, 9.0% of the respondents hold a master's degree. The remaining respondents have completed high school (4.0%), Sijil Pelajaran Malaysia (SPM), GCE O-Level or equivalent (3.0%), foundation (2.0%), and Sijil Tinggi Persekolahan Malaysia (STPM), GCE A-Level or equivalent (1.0%).

On the other hand, the majority of the respondents fall under the B40 income group (61.0%) with earning less than RM5,250 per month. This is followed by the M40 group (34.0%), whose income ranges from RM5,252 and RM11,819 and a small portion from the T20 group (5.0%), with monthly household incomes exceeding RM11,820. In terms of marital status, most respondents are single (62.0%), while 36.0% are married, and only 1.0% each are divorced or separated. Regarding their residential location, 35.0% of respondents reside in Kuala Lumpur, 25.0% in Putrajaya, 21.0% in Cyberjaya, and 19.0% in Shah Alam.

In addition, the ethnicity of the respondents shows that the majority are Chinese (55.0%), followed by Malays (28.0%) and Indians (17.0%). In terms of occupation, more than half of the respondents are employed full-time (53.0%), while students account for 34.0%. Other occupational categories include self-employed individuals (9.0%), retirees (2.0%), part-time employees (1.0%), and others (1.0%).

4.3 Cronbach's Alpha Reliability Test

Cronbach's Alpha Reliability Test was used in this study to assess the reliability of the data collected in Sections B and C of the questionnaire survey. Table 4.2 presents the Cronbach's Alpha values generated for Section B and Section C, recorded as 0.938 and 0.956. These results demonstrate a high level of internal consistency among the items in the questionnaire (Sekaran and Bougie, 2016). Hence, it can be inferred that the data obtained from both sections are adequately reliable for conducting further analyses in this study.

Table 4.2: Reliability Statistics of Section B and Section C

Section	**Cronbach Alpha**	**Cronbach's Alpha Based on Standardised Items**	**N of Items**
Section B: Readiness Level of Cities for Becoming Smart Sustainable Cities	0.938	0.937	21
Section C: Strategies to Improve City Readiness towards Smart Sustainable City	0.956	0.958	37

4.4 Arithmetic Mean

The readiness level of SSCs and non-SSCs and strategies to improve city readiness towards SSC were ranked and analysed according to the data collected from the respondents in this section.

4.4.1 Mean Ranking Comparison of Readiness Levels Between Smart and Non-Smart Sustainable Cities

Table 4.3 presents the overall mean ranking comparison of readiness levels between SSCs and non-SSCs according to the four aspects (Human Aspects, Technology Aspects, Economic Aspects, and Governance Aspects). In this study, Putrajaya and Cyberjaya are identified as SSCs, while Kuala Lumpur and Shah Alam are categorised as Non-SSCs for comparison purposes.

Table 4.3: Overall Mean Ranking Comparison of Readiness Levels between Smart Sustainable Cities and Non-Smart Sustainable Cities

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Smart Sustainable Cities Mean	Rank	Non-Smart Sustainable Cities Mean	Rank
AB	Technology Aspects	4.3130	1	3.8148	2
AA	Human Aspects	4.3087	2	3.9963	1
AD	Governance Aspects	4.2319	3	3.6296	4
AC	Economic Aspects	4.2174	4	3.7444	3

Table 4.3 shows that the scores for all aspects are consistently higher in SSC compared to non-SSC. In SSCs, the mean scores for readiness across all aspects are above 4.2, while in non-SSCs, the scores range from around 3.6 to 4.0. This suggests that SSCs demonstrate a generally stronger readiness across technology, human, government, and economic aspects, while non-SSCs still lag behind in every aspect.

In SSCs, Technology Aspects (AB) are ranked the highest with a mean value of 4.3130, indicating a strong focus on technological advancement as the driving force behind smart sustainability. This means that these cities are already equipped with certain technological infrastructure and systems. This also suggests that the city presents with digital tools such as smart sensors, data management systems, or efficient ICT networks that contribute to better service delivery, urban mobility, and environmental monitoring. For example, the Malaysian Ministry of Science implemented a national IoT strategic roadmap, which aims to enhance IoT adoption across multiple sectors (Bakhtiar and Samsudin, 2023).

On the other hand, non-SSCs have the highest mean ranking in Human Aspects (AA) with a mean value of 3.9963, with technology coming second, suggesting that these cities are ready in terms of human readiness. However, Technology Aspects (AB) in non-SSCs are still not ready as compared to SSCs. In Malaysia, initiatives such as digital platforms and smart citizen engagement apps reflect efforts to promote citizen participation in SSC development (Leong, Heng and Leong, 2023). Additionally, the integration of Twitter data and online news analysis offers insight into public sentiment, supporting more inclusive and responsive governance in cities like Kuala Lumpur (Mutiarin and Lawelai, 2023).

Furthermore, the Governance Aspects (AD) are ranked the lowest in non-SSCs. This highlights governance as a critical challenge for cities that have not yet transitioned to smart sustainable practices. Leong, Heng and Leong (2023) expressed that since the development of SSC in Malaysia is still ongoing, some aspects, such as scale, scope and SSC frameworks may not yet be fully completed. For example, Kuala Lumpur is still in the process of executing its Smart City Master Plan 2021–2025, reflecting a city in transition (Talib and Muhammad Taib, 2024). In particular, government-related initiatives may not be fully integrated at this stage. As seen in Putrajaya and Petaling Jaya, the political culture of e-decision-making remains underdeveloped and the implementation of e-platform initiatives, particularly in Putrajaya, is sub-standard (Lim and Yigitcanlar, 2022). This is aligned with the result obtained where the SSCs ranked third for the Governance Aspects (AD).

Additionally, Economic Aspects (AC) are ranked the lowest in SSCs. This means that even though the cities are considered relatively more advanced or developed in their journey towards SSCs, the economic foundations and outcomes are still the weakest area. Circular economy implementation, for example, is still in its infancy due to limited innovation, low investment in research and development, and fragmented waste data systems (Bahari, 2023). Apart from that, cities like Kuala Lumpur demonstrate inefficient resource allocation, where disparate energy management systems operate in silos, preventing synergies that could lead to both economic savings and improved environmental performance (Wong, 2024). This aligns with the finding that non-SSCs rank the lower mean in Economic Aspects (AC), indicating that inefficient resource allocation remains a persistent challenge.

Table 4.4: Mean Ranking Comparison of Readiness Levels between Smart Sustainable Cities and Non-Smart Sustainable Cities

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Smart Sustainable Cities Mean	Rank	Non-Smart Sustainable Cities Mean	Rank
AB4	The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	4.57	1	3.81	8
AA3	I am ready to use IT-based services and technologies in my current residential city.	4.54	2	4.19	1
AC5	There are sufficient initiatives that align with global Sustainable Development Goals (SDGs) to make my current residential city more sustainable and resilient.	4.37	3	3.83	7
AD3	There is an increasing of government’s capacity to use ICTs to meet community demands.	4.35	4	3.54	21
AA4	I will involve in urban development projects in my current residential city that would lead to better outcomes for creating a smart sustainable city.	4.33	5	4.06	2

Table 4.4 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Smart Sustainable Cities Mean	Rank	Non-Smart Sustainable Cities Mean	Rank
AB2	There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	4.33	5	3.69	14
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	4.3	7	3.72	13
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	4.3	7	3.61	18
AB1	There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city's infrastructure.	4.28	9	3.87	6
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	4.28	9	3.69	14

Table 4.4 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Smart Sustainable Cities Mean	Rank	Non-Smart Sustainable Cities Mean	Rank
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	4.28	9	3.57	20
AB3	There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	4.24	12	3.81	8
AA2	I am willing to participate in discussions or planning activities related to my current residential city's transformation into a smart sustainable city.	4.22	13	4	4
AA5	I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation.	4.17	14	4.06	2
AC2	There is an increasing use of circular economy practices, such as recycling and renewable energy.	4.17	14	3.78	12

Table 4.4 (Continued)

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Smart Sustainable Cities Mean**	**Rank**	**Non-Smart Sustainable Cities Mean**	**Rank**
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	4.17	14	3.63	16
AB5	There is an increasing use of technologies such as machine learning which can improve the service efficiency of the public transport.	4.15	17	3.89	5
AC4	There are environmental considerations taken into account while implementing smart sustainable city programs which can lead to long-term cost savings in my current residential city.	4.15	17	3.8	10
AD1	My current residential city’s government is actively working to innovate and provide effective solutions to local problems.	4.15	17	3.63	16
AD6	The government policies have prioritised societal benefits over environmental ones.	4.13	20	3.8	10

Table 4.4 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Smart Sustainable Cities Mean	Rank	Non-Smart Sustainable Cities Mean	Rank
AC1	There is an efficient resource allocation in my current residential city.	4.09	21	3.59	19

Table 4.4 shows the mean ranking comparison of readiness levels between SSCs and non-SSCs for sub-aspects. The comparison reveals that SSCs consistently show higher mean scores across all readiness indicators compared to on-SSCs. This suggests a stronger overall readiness in embracing smart technologies, sustainable practices, and citizen participation within SSCs. Although the ranks between SSCs and non-SSCs vary, the differences in mean scores highlight a significant gap in perceived and actual readiness levels between the two types of cities.

According to Table 4.4, the highest-ranked item for SSCs is AB4 = "The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city" with a mean value of 4.57. This reflects that transportation infrastructure is a core strength in SSC. For example, Putrajaya is well-connected through federal highways 29 on the western side and 30 on the eastern side, served by the Kuala Lumpur International Airport (KLIA) Express rail line with a station linking to Cyberjaya, and supported by RapidKL bus services, demonstrating the presence of integrated and accessible mobility options (Hong and Wong, 2017). For non-SSCs, the top-rated item is AA3 = "I am ready to use IT-based services and technologies in my current residential city" with a mean value of 4.19, reflecting residents' readiness to use IT-based services. While non-SSC show a willingness to engage with digital tools, they still lag in implementation, as shown by the lower ranks in infrastructure and governance items.

Besides, significant gaps are observed in aspects related to governance and smart technology integration. For example, AD3 = "There is an increasing of government's capacity to use ICTs to meet community demands" and AD2 = "There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation" are rated much higher in SSCs with a mean value of 4.35 and 4.28 compared to non-SSCs with a mean value of 3.54 and 3.57. These findings point to institutional readiness and digital governance as major areas where non-SSCs fall behind. For example, cities like Kuala Lumpur face challenges in these areas, such as fragmented coordination among agencies and limited integration of digital platforms, which hinder their progress compared to more advanced cities like Putrajaya (Ministry of Housing and Local Government, 2019). The low rankings in these categories highlight the need for non-SSCs to strengthen administrative capacity and strategic planning.

On the other hand, indicators related to citizen participation, such as AA5 = “I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation” and AA2 = “I am willing to participate in discussions or planning activities related to my current residential city’s transformation into a smart sustainable city”, also rank higher in SSCs compared to non-SSCs. This indicates that residents in SSCs are more engaged in their city's development, particularly in providing feedback and participating in planning activities. Also, Anthony (2023) stated that ongoing community participation allows residents to express their concerns and expectations to local authorities. In contrast, while non-SSCs also show some willingness among residents to participate, the lower scores imply that such engagement may be limited due to fewer initiatives or lower public awareness. This points to the need for non-SSCs to strengthen citizen involvement to support their smart city transformation.

Overall, the results suggest that while non-SSCs demonstrate a readiness in attitude, they are hindered by infrastructural and governance limitations. To bridge this gap, non-SSCs should focus on enhancing their policy frameworks, fostering innovation in governance, and investing in key technologies like IoT and data sharing platforms. Increasing public awareness and engagement can also accelerate transformation. These improvements will better position non-SSCs to progress toward becoming SSCs.

For SSCs, the findings reveal that while the overall mean value is high, certain aspects such as efficient resource allocation and governance show relatively lower rank. To maintain their status as SSCs, it is essential for these cities to focus on strengthening financial and resource management frameworks, promoting greater transparency and accountability in governance, and continuously advancing citizen participation initiatives. Addressing these areas will ensure that SSCs remain resilient, efficient, and adaptable in the face of evolving urban challenges.

4.4.2 Mean Ranking for Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities

Table 4.5 shows the overall mean ranking for strategies to improve the readiness level of cities to become SSCs. The eight main strategies are analysed as Education and Awareness Campaigns, Financial Incentives and Subsidies, Infrastructure Development, Policy and Regulatory Frameworks, Comprehensive Data Strategy, Pilot and Scale Smart Solutions, Planning for Long-Term Sustainability, and Secure Funding and Resources. According to Table 4.5, all of the strategies fall within the high level of effectiveness, with the highest mean value at 4.5250 and the lowest at 4.0867.

Table 4.5: Overall Mean Ranking of Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities

Code	Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities	Mean	Rank
BC	Infrastructure Development	4.5250	1
BF	Pilot and Scale Smart Solutions	4.3525	2
BH	Secure Funding and Resources	4.2700	3
BA	Education and Awareness Campaigns	4.2700	3
BD	Policy and Regulatory Frameworks	4.2500	5
BG	Planning for Long-Term Sustainability	4.2133	6
BE	Comprehensive Data Strategy	4.1500	7
BB	Financial Incentives and Subsidies	4.0867	8

According to Table 4.5, the highest mean ranking is Infrastructure Development (BC) with a mean value of 4.5250. This indicates that it is perceived as the most crucial strategy for enhancing the readiness level of cities to become SSCs. This high ranking may be attributed to the foundational role infrastructure plays in enabling smart technologies, such as high-speed internet, smart grids, public transportation systems, and energy-efficient buildings. Ibrahim, El-Zaart and Adams (2018) emphasised that city readiness involves a city's existing physical, organisational, and digital infrastructures, as well as the digital literacy of its population. Similarly, Khan *et al.* (2020) supported this view by highlighting that the initial phase of SSC development focuses on establishing communication and network infrastructure, underpinned by advancing technologies like ICT, IoT, and big data analytics. This suggests that infrastructure is not only a key enabler but also a prerequisite for other SSC components to function effectively.

Next, the second highest mean ranking is the Pilot and Scale Smart Solutions (BF) with a mean value of 4.3525. As noted by Woltering *et al.* (2019), pilot projects serve to assess the practicality and effectiveness of proposed solutions before wider deployment. Pilot projects are perceived as more manageable and adaptable, increasing their likelihood of success, especially in complex urban environments (Caragliu and Del Bo, 2018). Moreover, scaling successful pilots depends on effective stakeholder collaboration, where inclusive partnerships involving local governments, private sector actors, and residents help align solutions with real urban needs (Bundgaard and Borrás, 2021). By combining hands-on testing with collaboration and flexibility, this strategy is seen as a practical and effective way for cities to move toward becoming SSCs.

On the other hand, Financial Incentives and Subsidies (BB) is the lowest mean ranking with a mean value of 4.0867. Although it ranks the lowest among the listed strategies, the mean value still falls within the high range, indicating that respondents generally agree on its importance. This shows that while financial support mechanisms are still considered important, they are not viewed as the most immediate or impactful strategy in driving city readiness. Nonetheless, the Malaysian government’s latest Budget allocated RM15.1 million to the Housing and Local Government Ministry for SSC initiatives (Sharon, 2024). This is the largest amount allocated so far, reflecting the government’s continued commitment to support urban innovation through financial measures.

Table 4.6: Mean Ranking of Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities

Code	Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities	Mean	Rank
BC5	Invest in modern infrastructure, such as smart grids and digital networks.	4.62	1
BC4	Upgrade highways and roads with smart technology.	4.60	2
BC6	Upgrade existing infrastructure to integrate sustainable practices should be a priority for local governments.	4.57	3
BC2	Enhance public transport connections to minimise traffic congestion.	4.55	4
BA3	Utilise social networking services (e.g. Facebook) to increase public awareness about smart sustainable city and engaging citizens.	4.55	4
BC3	Improve technologies implementation such as Internet of Things and intelligent traffic systems.	4.48	6
BF3	Continuously monitoring and adapting smart sustainable city initiatives based on feedbacks to ensure their long-term success.	4.47	7
BH3	Adopt a balanced approach for funding innovation and sustainability.	4.42	8
BF2	Scale successful pilot projects across the city, customising them to meet the specific needs of each area.	4.37	9
BD6	Implement strong policies to support investment in 5G networks and the deployment of Internet of Things sensors across the city.	4.35	10
BC1	Enhance the infrastructure in the city (e.g. water supply, sewerage and power).	4.33	11

Table 4.6 (Continued)

Code	Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities	Mean	Rank
BF4	Evaluating smart sustainable city projects regularly to ensure the city’s technological advancements up to date.	4.33	11
BG3	Create a flexible policy framework to address evolving urban needs as part of the smart sustainable city transformation.	4.31	13
BD5	Allocate sufficient funding by government to promote smart sustainable initiatives.	4.31	13
BD4	Establish policies that focus on smart mobility and transportation management.	4.27	15
BD3	Implement national policies that prioritise urban sustainability.	4.27	15
BA2	Encourage citizen participation in urban planning and smart sustainable city initiatives.	4.27	15
BB3	Provide subsidies to encourage companies and individuals to invest in sustainable infrastructure for smart sustainable city development.	4.27	15
BH2	Prioritise budget allocation to secure essential resources for high-impact project.	4.24	19
BF1	Start with small-scale pilot projects to test smart sustainable city technologies before full implementation.	4.24	19
BA1	Organise campaigns to increase public awareness.	4.21	21
BD2	Foster collaboration between local government and various stakeholders, such as businesses and communities, can ensure effective implementation of smart sustainable city policies.	4.20	22

Table 4.6 (Continued)

Code	Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities	Mean	Rank
BE3	Leverage data analytics and Artificial Intelligence to optimise traffic congestion and energy usage.	4.19	23
BE4	Standardise governmental portal for better data disclosure and minimise conflicts.	4.18	24
BB2	Offer financial incentives, such as lower energy bills during off-peak hours, can increase citizen participation in smart sustainable city initiatives.	4.18	24
BA4	Evaluating public awareness and understanding of smart sustainable city.	4.18	24
BG2	Focus smart sustainable city solutions on enhancing resilience to environmental, economic, and social challenges.	4.17	27
BG1	Integrating smart sustainable city initiatives with urban planning to achieve long-term sustainability and liveability in the city.	4.16	28
BH1	Explore diverse funding sources, such as government grants, private investments, and international collaborations to support smart sustainable city projects.	4.15	29
BE2	Ensure data privacy and enforce ethical policies to increase citizen trust.	4.14	30
BA5	Implement awareness initiatives. For example, Change Readiness Index can help to assess the city’s readiness to transform into a smart sustainable city.	4.14	30
BB1	Provide government grants and subsidies to drive and accelerate smart sustainable city development.	4.12	32

Table 4.6 (Continued)

Code	Strategies for Improving the Readiness Level of Cities to Become Smart Sustainable Cities	Mean	Rank
BD1	Enact strong policies and regulations for guiding the transition to a smart sustainable city.	4.10	33
BE1	Create a centralised data platform that integrates information from various city services to improve decision-making in urban management.	4.09	34
BB6	Provide non-cash rewards, such as redeemable tokens for sustainable actions, encourages residents to engage in smart sustainable city initiatives.	4.06	35
BB5	Create digital platforms (e.g. Digital Social Market (DSM)) to motivate city residents to adopt sustainable practices.	3.97	36
BB4	Offer non-monetary incentives, such as public-private partnerships (PPPs).	3.92	37

Table 4.6 shows the means and rankings of the 37 strategies for improving the readiness level of cities to become SSCs. Based on Table 3.2, mean values ranging from 3.68 to 5.00 signify the high effectiveness of the strategy. Since all the values in the table are above 3.68, it suggests that every strategy reflects a strong level of effectiveness.

As shown in Table 4.6, the highest mean ranking of strategy is BC5 = "Invest in modern infrastructure, such as smart grids and digital networks" which is grouped under "Infrastructure Development (BC)" with a mean value of 4.62. This reflects strong agreement among respondents on the importance of upgrading core infrastructure to support SSC functions. Modern infrastructure forms the backbone of a SSC, enabling real-time data exchange, efficient energy management, and improved service delivery. For example, Iskandar Malaysia has implemented smart grid technology to optimise energy distribution and reduce waste, demonstrating the practical benefits of such investments in advancing urban sustainability (Inam, 2024).

Besides, BC4 = "Upgrade highways and roads with smart technology" is the second highest mean ranking of the strategy under the group of "Infrastructure Development (BC)" with a mean value of 4.60. This highlights the growing importance of integrating intelligent transportation systems to improve urban mobility and traffic management. Smart road technologies, such as adaptive traffic signals, real-time traffic monitoring, and connected vehicle systems, can enhance safety, reduce congestion, and support more efficient travel. Uchehara *et al.* (2022) emphasised that roads and highways are integral to modern daily life and will be pivotal in the development of sustainable cities. In the Malaysian context, Sazali and Firdaus (2019) noted that with 31 highways and expressways already in use and many more under development, Malaysia possesses one of the most extensive highway infrastructures among developed countries, making it a suitable foundation for implementing smart road technologies.

Furthermore, the third highest mean ranking is BC6 = "Upgrade existing infrastructure to integrate sustainable practices should be a priority for local governments" which is also grouped under "Infrastructure Development (BC)" with a mean value of 4.57. This highlights the importance of improving current infrastructure by embedding sustainable features such as energy efficiency, low-carbon materials, and smart technologies. Makarova *et al.* (2017) emphasised that transport systems, one of the vital components of SSCs, must integrate smart users, smart vehicles, and smart infrastructure to ensure both sustainability and safety. This reinforces the need for local governments to prioritise upgrading infrastructure to meet the evolving standards of SSCs.

Conversely, the second lowest mean ranking of the strategy is BB5 = "Create digital platforms (e.g. Digital Social Market (DSM)) to motivate city residents to adopt sustainable practices", categorised under "Financial Incentives and Subsidies (BB)" with a mean value of 3.97. This relatively lower ranking may be due to limited awareness or familiarity among the public about how such platforms operate. However, DSM tools have shown success in cities like Lisbon, London, and Milan, where smartphone applications have been used to engage residents and promote sustainable behaviours by offering rewards (Manca *et al.*, 2022). This suggests that while the concept is effective in practice, its lower ranking in this context might stem from a lack of exposure or implementation in the local setting.

In addition, BB4 = "Offer non-monetary incentives, such as public-private partnerships (PPPs)" which is also categorised under "Financial Incentives and Subsidies (BB)" is the lowest mean ranking with a value of 3.92. This may reflect a perception that non-monetary incentives are less direct or immediate in impact compared to financial aid. However, Wojewnik-Filipkowska and Węgrzyn (2019) emphasized that the growth of SSCs relies significantly on PPPs, which are collaborative efforts between the public and private sectors that can deliver substantial benefits, especially when human resources are limited. The mean value of this strategy may continue to be high due to this advantage. Nonetheless, the complexity of PPPs, due to lengthy concession periods and involvement of multiple stakeholders, may have led to concerns about their feasibility, contributing to the lower ranking (Suwardi and Saad, 2024).

4.5 Spearman's Correlation Test

Table 4.7 shows the correlation between the readiness level and the strategies to improve the readiness level of the cities. There are a total of 329 correlations. For the criteria for measuring readiness level, each of the 21 criteria has at least 3 significantly correlated influential strategies to improve the readiness, while each of the 37 strategy has at least 1 influential criteria.

According to Table 4.7, "I am ready to use IT-based services and technologies in my current residential city" (AA3) is the most significant criteria, which consist of 28 significant correlations. This indicates that citizen readiness to use IT-based services is a major indicator for assessing a city's readiness for transformation into a SSC. The Banyuasin District Government in Indonesia evaluated the community's readiness to adopt an IT-based SSC model, recognising the importance of readiness data in assessing citizen readiness for SSC initiatives (Antoni, Arpan, and Supratman, 2020). Therefore, it is necessary to evaluate citizen readiness to use IT-based services before pursuing the transformation into a SSC.

On the other hand, "Organise campaigns to increase public awareness" (BA1) is the most outstanding strategy, with 20 significant correlations. This suggests that organising public awareness campaigns appears to be a central and influential strategy for improving city readiness. Alamoudi, Abidoye and Lam (2022) support the idea that increasing citizen awareness and promoting their involvement can bridge top-down and bottom-up approaches in urban planning and decision-making, leading to a more rapid improvement in SSC policies and governance. This is further supported by Khan *et al.* (2020), who emphasise that many citizens lack awareness of the services offered by SSC, underscoring the need for raising citizen knowledge to fully realise the potential benefits of a SSC. Thus, enhancing public awareness is a crucial step in ensuring successful SSC transformation, as it fosters greater citizen engagement and supports more effective policy and governance integration.

The highest correlation observed is "There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city's infrastructure" (AB1) and "Encourage citizen participation in urban planning and smart sustainable city initiatives" (BA2), with the correlation coefficient of 0.483. This indicates that greater technological integration is associated with more active citizen engagement in shaping SSC initiatives, suggesting that both elements are mutually reinforcing factors for improving city readiness levels. According to Shwedeh *et al.* (2022), technology readiness is crucial for the sustainability of SSC, as demonstrated by Dubai's rapid transition into a SSC due to its technological advancements. However, the mere adoption of technology is insufficient without citizen involvement. Alakavuk *et al.* (2023) argue that city residents play a critical role in urban development and that effective participation mechanisms are essential for the success of SSC initiatives. Practical examples, such as China's legislative mandate for public engagement and Thailand's Khon Kaen SSC project utilising TOD to engage citizens, illustrate how citizen participation often complements technological innovation (Staletić *et al.*, 2020; Lhakard, 2021).

The second highest correlation shown is "The government policies have prioritised societal benefits over environmental ones" (AD6) and "Implement awareness initiatives. For example, Change Readiness Index can help to assess the city's readiness to transform into a smart sustainable city" (BA5) with a correlation coefficient of 0.457. Cavada, Tight and Rogers (2019) illustrated that a strong top-down approach focusing on societal well-being, rather than purely environmental concerns, contributed to Singapore's success as a SSC. In line with this, Tomor *et al.* (2019) emphasise that maintaining public satisfaction through continuous enhancement of e-participation initiatives is critical for establishing effective smart governance in SSC. Awareness initiatives, such as the adoption of the CRI, further support this transition by evaluating a city's ability to manage long-term growth and readiness for change (Nasrawi, Adams & El-Zaart, 2016). Thus, cities that prioritise societal benefits are more inclined to implement structured awareness programs that enhance public readiness and governance capacity for SSC transformation.

Next, the third highest correlation presented is "There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable" (AC3) and "Organise campaigns to increase public awareness" (BA1). SSC aims to integrate environmental, social, and economic objectives across all levels of city planning (Ibrahim, El-Zaart and Adams, 2018). Awareness campaigns play a vital role in supplementing formal

SSC strategies by fostering knowledge and encouraging sustainable behaviour at the community level (Fan and Fan, 2024). The result suggests that public engagement through awareness campaigns becomes critical to reinforce sustainability-focused initiatives such as waste reduction and efficient resource use. The result further reflects that technical initiatives aligned with the circular economy require community support and behavioural changes to be successful (Formisano *et al.*, 2022). Given that circular economy practices depend on public behaviour shifts, such as recycling and reuse, public participation becomes essential (Gonzalez *et al.*, 2023). Therefore, awareness campaigns act as a necessary bridge between policy initiatives and real-world impact by promoting understanding and encouraging behavioural change.

Table 4.7: Correlation between the Readiness Criteria and the Strategies to Improve the Readiness Level of the Cities

Strategies \ Criteria	**AA1**	**AA2**	**AA3**	**AA4**	**AA5**	**AB1**	**AB2**	**AB3**	**AB4**	**AB5**	**AC1**	**AC2**	**AC3**	**AC4**	**AC5**	**AD1**	**AD2**	**AD3**	**AD4**	**AD5**	**AD6**	**Total Correlation**
BA1	.244 *	.273 **	.261 **	.240 *	-	.382 **	.331 **	.400 **	.401 **	.270 **	.284 **	.229 *	**.449** **	.276 **	.404 **	.323 **	.269 **	.287 **	.379 **	.244 *	.280 **	**20**
BA2	.312 **	.345 **	.313 **	-	-	**.483** **	.393 **	.283 **	.370 **	.353 **	.225 *	.300 **	.364 **	.322 **	.379 **	.270 **	.235 *	.371 **	.335 **	-	.255 *	18
BA3	-	-	.332 **	-	-	.204 *	.290 **	.212 *	.369 **	.299 **	-	.212 *	-	.225 *	.283 **	.219 *	-	.307 **	.390 **	-	.261 **	13
BA4	-	-	-	.207 *	-	-	-	-	-	.212 *	.243 *	.212 *	-	.235 *	.238 *	-	.204 *	.211 *	.235 *	.242 *	.268 **	11
BA5	-	-	.230 *	.204 *	-	-	-	.260 **	-	-	-	-	.403 **	.367 **	.228 *	.197 *	.254 *	.240 *	.288 **	.236 *	**.457** **	12
BB1	-	-	.272 **	-	-	-	-	-	-	-	-	-	-	.254 *	.323 **	-	-	-	-	-	.227 *	4
BB2	-	-	.225 *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
BB3	-	-	-	-	-	-	-	-	-	-	-	-	-	.243 *	-	-	-	.234 *	-	-	-	2

Table 4.7 (Continued)

Strategies \ Criteria	AA1	AA2	AA3	AA4	AA5	AB1	AB2	AB3	AB4	AB5	AC1	AC2	AC3	AC4	AC5	AD1	AD2	AD3	AD4	AD5	AD6	Total Correlation
BB4	-	-	-	-	-	-	-	-	-	-	-	-	.220*	.331**	-	-	-	.253*	-	-	-	3
BB5	-	-	.199*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
BB6	-	-	-	-	-	-	-	-	-	-	-	-	-	.231*	-	-	-	-	-	-	-	1
BC1	-	-	.286**	-	-	.290**	.304**	-	-	.223*	-	-	-	-	-	-	-	-	-	-	-	4
BC2	-	-	.269**	-	-	.350**	.204*	-	-	-	.229*	-	-	-	-	.279**	.221*	.306**	.247*	.244*	.331**	10
BC3	-	-	.272**	-	-	.206*	.238*	.198*	-	.249*	-	-	-	-	-	-	-	.239*	-	-	-	6
BC4	-	-	.316**	-	-	.249*	.338**	-	.351**	.235*	-	-	-	-	-	.316**	-	.398**	.269**	.236*	.334**	10
BC5	-	-	.257**	-	-	-	.224*	.227*	.296**	.237*	-	-	-	.222*	.202*	-	-	.333**	.352**	.236*	.236*	11
BC6	-	-	.290**	-	-	.364**	.255*	-	.301**	.217*	-	-	.252*	.217*	-	.270**	.266**	.336**	-	-	.298**	11

Table 4.7 (Continued)

Criteria / Strategies	AA1	AA2	AA3	AA4	AA5	AB1	AB2	AB3	AB4	AB5	AC1	AC2	AC3	AC4	AC5	AD1	AD2	AD3	AD4	AD5	AD6	Total Correlation
BD1	-	-	-	-	-	-	-	-	-	-	-	-	-	.311**	-	-	-	-	.223*	-	.222*	3
BD2	-	-	-	-	-	.326**	-	-	-	.198*	-	-	-	.299**	.198*	-	-	.227*	-	-	.259**	6
BD3	.216*	-	.366**	-	-	.411**	.256*	.202*	.369**	.279**	-	-	.202*	.252*	-	-	-	.303**	.242*	-	.310**	12
BD4	-	.270**	.220*	-	-	-	-	-	-	.257**	-	-	.270**	-	-	-	-	-	-	.223*	-	5
BD5	-	-	.301**	-	-	-	.251*	-	-	.205*	-	-	-	-	.212*	-	-	-	-	-	.223*	5
BD6	-	.236*	.290**	-	.224*	.280**	-	-	.224*	.254*	-	-	-	.256*	-	-	-	-	.264**	-	-	8
BE1	-	.206*	-	.235*	.250*	-	-	-	-	.245*	-	-	-	.200*	-	-	-	-	-	-	-	5
BE2	-	-	-	-	-	.237*	-	.213*	-	.340**	-	-	.209*	-	-	-	-	-	-	.197*	.274**	6
BE3	.271**	.293**	.320**	.235*	-	.199*	.211*	.304**	-	.305**	-	.305**	.275**	.232*	.261**	-	.217*	.333**	.264**	.285**	.310**	17

Table 4.7 (Continued)

Strategies \ Criteria	AA1	AA2	AA3	AA4	AA5	AB1	AB2	AB3	AB4	AB5	AC1	AC2	AC3	AC4	AC5	AD1	AD2	AD3	AD4	AD5	AD6	Total Correlation
BE4	.276**	-	.274**	-	-	.287**	.255*	.343**	.327**	.218*	-	-	.312**	.291**	.278**	-	.244*	.338**	.259**	.242*	.384**	15
BF1	-	.276**	.400**	-	-	.293**	-	-	.294**	-	.282**	-	-	.233*	.273**	-	-	.206*	.242*	-	.320**	10
BF2	.224*	.212*	.375**	-	-	.294**	.302**	.262**	.388**	.261**	.246*	-	-	-	.305**	.296**	.231*	.368**	.221*	.257**	.323**	16
BF3	-	-	.359**	-	-	.253*	-	.242*	-	-	.238*	-	-	-	-	.303**	-	.280**	.249*	.262**	.241*	9
BF4	.235*	-	.333**	-	-	.289**	.207*	.215*	-	.205*	-	-	-	-	-	-	-	-	-	-	.381**	7
BG1	.222*	.224*	.234*	.245*	-	-	-	.220*	-	.222*	-	-	-	-	.208*	-	-	-	-	-	-	7
BG2	-	.227*	-	.313**	.271**	.260**	.245*	.227*	-	.298**	-	-	.300**	-	.251*	-	-	-	-	.214*	.214*	11
BG3	.231*	.383**	.354**	.254*	-	.252*	.291**	.288**	.331**	.285**	-	.212*	.249*	.334**	.376**	-	-	.207*	.270**	.311**	.296**	17
BH1	-	.347**	.266**	-	-	.267**	.264**	-	.310**	-	-	-	-	-	.281**	-	-	-	.260**	-	-	7

Table 4.7 (Continued)

Strategies \ Criteria	**AA1**	**AA2**	**AA3**	**AA4**	**AA5**	**AB1**	**AB2**	**AB3**	**AB4**	**AB5**	**AC1**	**AC2**	**AC3**	**AC4**	**AC5**	**AD1**	**AD2**	**AD3**	**AD4**	**AD5**	**AD6**	**Total Correlation**
BH2	.221*	-	.241*	-	-	.227*	.331**	.376**	.294**	-	-	-	-	.333**	.212*	-	-	.206*	.255*	-	-	10
BH3	-	.291**	.273**	-	-	.304**	.216*	.249*	.275**	.247*	-	.220*	.208*	-	.330**	.300**	-	.267**	.271**	.214*	.260**	15
Total Correlation	10	13	**28**	8	3	23	20	18	15	24	7	7	13	21	19	10	9	22	20	15	24	

Note: **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.6 Kruskal-Wallis Test

The Kruskal-Wallis Test is adopted to identify significant differences in the city readiness towards SSC across various social demographics. These differences are assessed by analysing the p-value and calculating the chi-square value, considering the degrees of freedom.

4.6.1 Kruskal-Wallis Test on Age Group

Kruskal-Wallis Test is used to reveal the significant differences in the city readiness towards SSC across different age groups, including 21-30 years old, 31-40 years old, 41-50 years old, and 51-60 years old. Four groups of respondents were evaluated, and significant differences are present when the p-value is below 0.05. Therefore, the critical chi-square value is 7.815, determined by a degree of freedom of 3.

The two hypotheses are presented as follows:

Null hypothesis (H_0): If the H-value is less than 7.815, there is no significant difference across the age groups in the city readiness.

Alternative hypothesis (H_1): If the H-value is more than 7.815, there is a significant difference across the age groups in the city readiness.

Table 4.8: Kruskal-Wallis Test on Age Group

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Chi-square**	**Asymptotic Significance**
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	9.389	.025

Table 4.8 shows the result of the Kruskal-Wallis Test on age groups. AD2 = “There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation” under the category of “Governance Aspects (AD)” has a p-value less than 0.05

and a chi-square value larger than 7.815. This indicates that there is a significance difference in perspective across the age groups of 21-30 years old, 31-40 years old, 41-50 years old, and 51-60 years old on the city readiness. Therefore, the null hypothesis (H_0) for this criteria is rejected.

Table 4.9: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Age Group

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Age Group	N	Mean Rank
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	*21-30 years old*	53	*45.46*
		31-40 years old	25	48.54
		41-50 years old	16	**67.56**
		51-60 years old	6	57.67

Note: **Bold** indicates the highest mean rank
Italic indicates the lowest mean rank

As shown in Table 4.9, the Kruskal-Wallis test revealed a statistically significant difference in city readiness perceptions across age groups, with respondents aged 41–50 reporting higher levels of agreement regarding the sufficiency of vision, policies, initiatives, and governance within their current residential city. This finding is attributed to generational differences in information creation and perception toward SSC transformation, as identified by Shin, Kim and Chun (2021). Moreover, Sameer *et al.* (2023) highlighted that middle-aged individuals are generally more prepared and willing to participate in DPP processes compared to younger and older generations, which may explain their higher confidence in the city's readiness for SSC transition. Consequently, they are likely more aware of governmental strategies and urban transformation policies. This result also suggests that while middle-aged citizens may perceive progress, additional efforts may be required to enhance awareness and confidence among younger and older populations to ensure inclusive support for SSC initiatives.

4.6.2 Kruskal-Wallis Test on Educational Level

In this section, three respondent groups with low (High School / SPM / GCE O-Level / STPM / GCE A-Level), medium (bachelor's degree), and high (master's / PhD) educational levels were assessed, and notable differences were observed when the p-value was less than 0.05. As a result, the critical chi-square value is 5.991, calculated based on 2 degrees of freedom.

The two hypotheses are presented as follows:

Null hypothesis (H_0): If the H-value is less than 5.991, there is no significant difference across the educational levels in the city readiness.

Alternative hypothesis (H_1): If the H-value is more than 5.991, there is a significant difference across the educational levels in the city readiness.

Table 4.10: Kruskal-Wallis Test on Educational Level

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Chi-square	Asymptotic Significance
AA5	I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation.	6.088	.048

Table 4.10 shows the result of the Kruskal-Wallis Test on educational level. This table indicates AA5 = "I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation" under the "Human Aspects (AA)" has a p-value below 0.05 and a chi-square value greater than 5.991. This implies that there is a noteworthy difference in the perspective of city readiness among the low, medium, and high educational levels. Therefore, the null hypothesis (H_0) for this criteria is rejected.

Table 4.11: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Educational Level

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Educational Level	N	Mean Rank
AA5	I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation.	*Low*	35	*42.37*
		Medium	56	**55.10**
		High	9	53.50

Note: **Bold** indicates the highest mean rank
Italic indicates the lowest mean rank

As exemplified in Figure 4.11, the medium educational level group is more likely to provide feedback or engage with local government initiatives related to the SSC transformation than the other educational levels. Respondents with a medium educational level, corresponding to bachelor's degree holders, demonstrated a greater likelihood of providing feedback and participating in local SSC initiatives. This finding aligns with Barachi *et al.* (2022), who reported that individuals with bachelor's degrees are comparatively tech-savvy, suggesting that their familiarity with technology and urban digitalisation may contribute to higher levels of civic engagement. Furthermore, Sameer *et al.* (2023) indicated that residents with lower educational attainment tend to exhibit less confidence in participatory processes. Conversely, Barachi *et al.* (2022) obtained that although individuals with master's degrees and above are also technologically proficient, their engagement may occur at broader strategic or policy-driven levels, potentially reducing their participation in local feedback initiatives. Therefore, bachelor's degree holders serve as a critical bridge between technological understanding and active local involvement in SSC transformation efforts.

4.6.3 Kruskal-Wallis Test on Income Level

The two hypotheses are presented as follows:

Null hypothesis (H_0): If the H-value is less than 5.991, there is no significant difference across the income levels in the city readiness.

Alternative hypothesis (H_1): If the H-value is more than 5.991, there is a significant difference across the income levels in the city readiness.

Table 4.12: Kruskal-Wallis Test on Income Level

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Chi-square	Asymptotic Significance
AC1	There is an efficient resource allocation in my current residential city.	9.254	.010
AC2	There is an increasing use of circular economy practices, such as recycling and renewable energy.	10.782	.005
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	9.397	.009
AD1	My current residential city’s government is actively working to innovate and provide effective solutions to local problems.	6.171	.046
AD3	There is an increasing of government’s capacity to use ICTs to meet community demands.	7.651	.022

Table 4.12 presents the Kruskal-Wallis Test results based on income levels, identifying five criteria with a p-value below 0.05 and a chi-square exceeding 5.991. The criteria are AC1 = "There is an efficient resource allocation in my current residential city", AC2 = "There is an increasing use of circular economy practices, such as recycling and renewable energy", AC3 = "There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable", AD1 = "My current residential city's government is actively working to innovate and provide effective solutions to local problems" and AD3 = "There is an increasing of government's capacity to use ICTs to meet community demands". Thus, the null hypothesis (H_0) for these five criteria is rejected.

Table 4.13: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Income Level

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Income Level	N	Mean Rank
AC1	There is an efficient resource allocation in my current residential city.	B40	61	50.81
		M40	34	**54.75**
		T20	5	*17.80*
AC2	There is an increasing use of circular economy practices, such as recycling and renewable energy.	**B40**	61	**54.49**
		M40	34	48.53
		T20	5	*15.20*
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	**B40**	61	**52.50**
		M40	34	52.01
		T20	5	*15.80*
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	B40	61	50.41
		M40	34	**54.32**
		T20	5	*25.60*

Table 4.13 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Income Level	N	Mean Rank
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	B40	61	49.60
		M40	34	**56.41**
		T20	5	*21.30*

Note: **Bold** indicates the highest mean rank
Italic indicates the lowest mean rank

As shown in Table 4.13, the low income group "B40" has the highest mean rank in "Economic Aspects (AC)" when compared to other income levels. This suggests that lower-income citizens are more sensitive to and appreciative of initiatives promoting circular economy practices and sustainability efforts. According to Shayan and Kim (2023), lower-income groups are more vulnerable to social exclusion if SSC solutions are not affordable and accessible, making them more aware of tangible economic improvements. Furthermore, Biresselioglu, Demir and Altinci (2022) noted that lower-income individuals prioritise affordability and accessibility, aligning with the higher satisfaction seen among B40 respondents regarding economic readiness.

In contrast, the M40 income group exhibited higher mean ranks for "Governance Aspects (AD)", indicating a more favourable perception of government efforts in fostering SSC transformation. This suggests that middle-income citizens are more aware of or more responsive to visible government initiatives related to innovation and ICT capacity development. However, this finding appears to contrast with previous research by Panyavaranant *et al.* (2023), which suggested that middle-income citizens tend to have lower participation rates in SSC initiatives. While the M40 respondents in this study perceived government efforts positively, it may reflect a higher level of awareness or approval rather than direct civic engagement.

4.6.4 Kruskal-Wallis Test on Ethnicity

In this section, three groups of respondents were analysed, with significant differences identified when the p-value was below 0.05. Consequently, the critical chi-square value, determined using 2 degrees of freedom, was 5.991.

The two hypotheses are presented as follows:

Null hypothesis (H_0): If the H-value is less than 5.991, there is no significant difference across the educational levels in the city readiness.

Alternative hypothesis (H_1): If the H-value is more than 5.991, there is a significant difference across the educational levels in the city readiness.

Table 4.14: Kruskal-Wallis Test on Ethnicity

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Chi-square	Asymptotic Significance
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	8.158	.017
AA2	I am willing to participate in discussions or planning activities related to my current residential city’s transformation into a smart sustainable city.	6.241	.044
AA3	I am ready to use IT-based services and technologies in my current residential city.	15.579	<.001
AB2	There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	6.306	.043

Table 4.14 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Chi-square	Asymptotic Significance
AB3	There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	7.615	.022
AB4	The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	18.068	<.001
AC1	There is an efficient resource allocation in my current residential city.	7.715	.021
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	8.726	.013
AC5	There are sufficient initiatives that align with global Sustainable Development Goals (SDGs) to make my current residential city more sustainable and resilient.	7.310	.026
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	19.668	<.001

Table 4.14 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Chi-square	Asymptotic Significance
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	20.846	<.001
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	26.204	<.001
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	10.902	.004
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	14.160	.001

According to Table 4.14, 14 criteria show an asymptotic significance of less than 0.05 and a chi-square value greater than 7.815. This suggests that significant differences exist among respondents from different ethnicities. As a result, the null hypothesis (H_0) is rejected for these 14 criteria.

Table 4.15: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Ethnicity

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Ethnicity**	**N**	**Mean Rank**
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	**Malay**	28	**60.77**
		Chinese	55	*44.02*
		Indian	17	54.56
AA2	I am willing to participate in discussions or planning activities related to my current residential city's transformation into a smart sustainable city.	**Malay**	28	**60.77**
		Chinese	55	47.42
		Indian	17	*43.56*
AA3	I am ready to use IT-based services and technologies in my current residential city.	**Malay**	28	**66.29**
		Chinese	55	45.56
		Indian	17	*40.47*
AB2	There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	**Malay**	28	**59.91**
		Chinese	55	*44.62*
		Indian	17	54.03
AB3	There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	Malay	28	58.43
		Chinese	55	*43.91*
		Indian	17	**58.76**
AB4	The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	**Malay**	28	**66.82**
		Chinese	55	*40.95*
		Indian	17	54.50

Table 4.15 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Ethnicity	N	Mean Rank
AC1	There is an efficient resource allocation in my current residential city.	**Malay**	28	**59.66**
		Chinese	55	*44.23*
		Indian	17	55.71
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	**Malay**	28	**62.50**
		Chinese	55	*44.72*
		Indian	17	49.44
AC5	There are sufficient initiatives that align with global Sustainable Development Goals (SDGs) to make my current residential city more sustainable and resilient.	**Malay**	28	**60.29**
		Chinese	55	*44.22*
		Indian	17	54.71
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	**Malay**	28	**64.88**
		Chinese	55	*41.07*
		Indian	17	57.32
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	**Malay**	28	**65.82**
		Chinese	55	*39.86*
		Indian	17	59.68
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	**Malay**	28	**67.91**
		Chinese	55	*38.23*
		Indian	17	61.53

Table 4.15 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Ethnicity	N	Mean Rank
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	**Malay**	28	**62.02**
		Chinese	55	*42.61*
		Indian	17	57.06
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	**Malay**	28	**64.02**
		Chinese	55	*42.15*
		Indian	17	55.26

Note: **Bold** indicates the highest mean rank
Italic indicates the lowest mean rank

Table 4.15 demonstrates that Malays consistently achieved the highest mean ranks across various indicators of city readiness. Malays scored highest in aspects such as awareness of public projects (AA1), willingness to participate in planning activities (AA2), readiness to use IT-based services (AA3), and perception of the government's initiatives towards smart transformation (AD2). This higher ranking suggests that Malays may exhibit stronger trust and engagement with government-led urban initiatives. Research by Elfartas, Albeera and Jibri (2022) also supports this, indicating that Malays are more active users of urban public spaces compared to Chinese and Indian communities, suggesting greater familiarity and acceptance of public-oriented development projects.

In contrast, Chinese respondents consistently recorded the lowest mean ranks across almost all city readiness measures, particularly in areas related to awareness of government initiatives (AD2), perception of smart mobility options (AB4), and trust in the government's use of ICTs (AD3). Noor *et al.* (2024) highlighted that Chinese Malaysians generally demonstrate a high acceptance of technological advancements with approximately 75% showing positive attitudes toward SSC concepts. This finding contrasted with the results obtained in this study, where Chinese respondents recorded the lowest mean ranks across various readiness indicators. Apart from that, Loheswar (2024) reveal that 57% of Chinese Malaysians feel unfairly treated, which could dampen their trust and willingness to participate in national SSC programs perceived as favouring other groups. This perceived marginalisation, coupled with a critical evaluation of government efforts, likely contributes to the lower readiness scores among Chinese respondents.

4.7 Mann-Whitney U Test

The Mann-Whitney U test is used to determine significant differences in city readiness across various sociodemographic factors, including gender, marital status, residential state, and income level of respondents. A p-value of 0.05 is set as the threshold for significance.

4.7.1 Mann-Whitney U Test on Gender

Two hypotheses are formulated for this test as below:

Null hypothesis (H_0): If $p > 0.05$, there is no significant difference in city readiness between the genders.

Alternative hypothesis (H_1): If $p \leq 0.05$, there is a significant difference in city readiness between the genders.

Table 4.16: Mann-Whitney U Test on Gender

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Mann-Whitney U**	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
AA1	I am aware of public projects and initiatives for transforming my current residential	955.000	2083.000	-2.233	.026

Table 4.16 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
	city into a smart sustainable city.				
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	951.000	2079.000	-2.444	.015
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	900.000	2028.000	-2.582	.010
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	949.000	2077.000	-2.211	.027

Table 4.16 presents the results of the Mann-Whitney U test for gender differences. It shows that four criteria for measuring city readiness levels have p-values below 0.05. The findings indicate that males and females have

significantly different perceptions of these readiness levels. Therefore, the null hypothesis (H_0) is rejected for these four criteria.

Table 4.17: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Gender

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Gender**	**N**	**Mean Rank**	**Sum of Ranks**
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	**Male**	**53**	**55.98**	**2967.00**
		Female	47	44.32	2083.00
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	**Male**	**53**	**56.06**	**2971.00**
		Female	47	44.23	2079.00
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	**Male**	**53**	**57.02**	**3022.00**
		Female	47	43.15	2028.00

Table 4.17 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Gender	N	Mean Rank	Sum of Ranks
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	**Male**	**53**	**56.09**	**2973.00**
		Female	47	44.19	2077.00

Note: **Bold** indicates the highest mean rank

According to Table 4.17, Males have a higher mean rank than female in four criteria. Specifically, males reported greater awareness of public projects and initiatives aimed at transforming their city (AA1), perceived stronger governmental efforts to innovate and solve local issues (AD1), observed a higher capacity of the government to utilise ICTs to meet community needs (AD2), and viewed the local government as more effective in collaborating with citizens through technology (AD3). This gender-based difference may be explained by prior findings, where women are often more cautious and have higher expectations before adopting SSC services (Huang *et al.*, 2022). Besides, Shin, Kim and Chun (2021) claimed that women tend to have less exposure and motivation toward ICT use compared to men. On the contrary, men generally express greater trust in authorities and a stronger willingness to collaborate (Sameer *et al.*, 2023). This would contribute to their more favourable perceptions of SSC initiatives compared to women.

4.7.2 Mann-Whitney U Test on Marital Status

Two hypotheses are formulated for this test as below:

Null hypothesis (H_0): If $p > 0.05$, there is no significant difference in city readiness between the single and married.

Alternative hypothesis (H_1): If $p \leqslant 0.05$, there is a significant difference in city readiness between the single and married.

Table 4.18: Mann-Whitney U Test on Marital Status

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Mann-Whitney U**	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	879.000	2959.000	-2.356	.018
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	725.000	2805.000	-3.405	.001
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	773.000	2853.000	-2.945	.003

Table 4.18 (Continued)

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Mann-Whitney U**	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	879.000	2959.000	-2.214	.027

Table 4.18 displays the Mann-Whitney U test results for marital status, revealing that four criteria assessing city readiness levels have p-values less than 0.05. The results suggest that single and married perceive these readiness levels significantly differently. Consequently, the null hypothesis (H_0) is rejected for these four criteria.

Table 4.19: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Marital Status

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Marital Status**	**N**	**Mean Rank**	**Sum of Ranks**
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	Single	64	46.23	2959.00
		Married	**36**	**58.08**	**2091.00**

Table 4.19 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Marital Status	N	Mean Rank	Sum of Ranks
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	Single	64	43.83	2805.00
		Married	**36**	**62.36**	**2245.00**
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	Single	64	44.58	2853.00
		Married	**36**	**61.03**	**2197.00**
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	Single	64	46.23	2959.00
		Married	**36**	**58.08**	**2091.00**

Note: **Bold** indicates the highest mean rank

Based on Table 4.19, married exhibit a higher mean rank than single across four criteria. The criteria include married respondents perceived stronger governmental efforts to innovate and solve local problems (AD1), recognized greater vision, policies, and governance supporting SSC transformation (AD2), observed a growing governmental capacity to utilize ICTs to meet community needs (AD3), and acknowledged more continuous improvements in e-participation initiatives aimed at maintaining public satisfaction (AD5). These results are consistent with previous studies, which show that married individuals tend to exhibit significantly higher levels of SSC literacy compared to non-married individuals, possibly due to their greater awareness of and support for sustainability initiatives that align with family-oriented priorities (Lee, Kang and Kim, 2024). However, it is important to note that marital status alone does not fully determine one's ability to engage with the community or public initiatives, as individual experiences and motivations can vary widely (Alamoudi, Abidoye and Lam, 2023).

4.7.3 Mann-Whitney U Test on Residential State

Two hypotheses are formulated for this test as below:

Null hypothesis (H_0): If $p > 0.05$, there is no significant difference in city readiness between the SSCs and non-SSCs.

Alternative hypothesis (H_1): If $p \leqslant 0.05$, there is a significant difference in city readiness between the SSCs and non-SSCs.

Table 4.20: Mann-Whitney U Test on Residential State

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	839.500	2324.500	-3.098	.002
AA3	I am ready to use IT-based services and technologies in my current residential city.	893.000	2378.000	-2.760	.006

Table 4.20 (Continued)

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Mann-Whitney U**	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
AB1	There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city's infrastructure.	885.500	2370.500	-2.752	.006
AB2	There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	803.000	2288.000	-3.263	.001
AB3	There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	956.500	2441.500	-2.169	.030

Table 4.20 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
AB4	The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	643.000	2128.000	-4.526	<.001
AC1	There is an efficient resource allocation in my current residential city.	921.000	2406.000	-2.536	.011
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	919.000	2404.000	-2.495	.013
AC5	There are sufficient initiatives that align with global Sustainable Development Goals (SDGs) to make my current residential	894.000	2379.000	-2.630	.009

Table 4.20 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
	city more sustainable and resilient.				
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	761.000	2246.000	-3.997	<.001
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	702.000	2187.000	-4.147	<.001
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	634.000	2119.000	-4.550	<.001
AD4	The local government effectively collaborates with citizens through	810.500	2295.500	-3.222	.001

Table 4.20 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
	technology to address urban issues and promote my current residential city's growth.				
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	818.000	2303.000	-3.312	.001
AD6	The government policies have prioritised societal benefits over environmental ones.	965.500	2450.500	-2.205	.027

Table 4.20 presents the Mann-Whitney U test outcomes for residential state, indicating that four criteria related to city readiness levels have p-values below 0.05. The findings imply that SSCs and non-SSCs have significantly different perceptions of these readiness levels. As a result, the null hypothesis (H_0) is rejected for these four criteria.

Table 4.21: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Residential State

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Residential State	N	Mean Rank	Sum of Ranks
AA1	I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.	**SSCs**	**46**	**59.25**	**2725.50**
		Non-SSCs	54	43.05	2324.50
AA3	I am ready to use IT-based services and technologies in my current residential city.	**SSCs**	**46**	**58.09**	**2672.00**
		Non-SSCs	54	44.04	2378.00
AB1	There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city's infrastructure.	**SSCs**	**46**	**58.25**	**2679.50**
		Non-SSCs	54	43.90	2370.50
AB2	There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	**SSCs**	**46**	**60.04**	**2762.00**
		Non-SSCs	54	42.37	2288.00

Table 4.21 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Residential State	N	Mean Rank	Sum of Ranks
AB3	There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	**SSCs**	**46**	**56.71**	**2608.50**
		Non-SSCs	54	45.21	2441.50
AB4	The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	**SSCs**	**46**	**63.52**	**2922.00**
		Non-SSCs	54	39.41	2128.00
AC1	There is an efficient resource allocation in my current residential city.	**SSCs**	**46**	**57.48**	**2644.00**
		Non-SSCs	54	44.56	2406.00
AC3	There are sufficient initiatives that focus on reducing waste, emissions, and	**SSCs**	**46**	**57.52**	**2646.00**
		Non-SSCs	54	44.52	2404.00

Table 4.21 (Continued)

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Residential State**	**N**	**Mean Rank**	**Sum of Ranks**
	resource input make urban areas more sustainable.				
AC5	There are sufficient initiatives that align with global Sustainable Development Goals (SDGs) to make my current residential city more sustainable and resilient.	**SSCs**	**46**	**58.07**	**2671.00**
		Non-SSCs	54	44.06	2379.00
AD1	My current residential city's government is actively working to innovate and provide effective solutions to local problems.	**SSCs**	**46**	**60.96**	**2804.00**
		Non-SSCs	54	41.59	2246.00
AD2	There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	**SSCs**	**46**	**62.24**	**2863.00**
		Non-SSCs	54	40.50	2187.00

Table 4.21 (Continued)

Code	**Readiness Level of Cities for Becoming Smart Sustainable Cities**	**Residential State**	**N**	**Mean Rank**	**Sum of Ranks**
AD3	There is an increasing of government's capacity to use ICTs to meet community demands.	**SSCs**	**46**	**63.72**	**2931.00**
		Non-SSCs	54	39.24	2119.00
AD4	The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city's growth.	**SSCs**	**46**	**59.88**	**2754.50**
		Non-SSCs	54	42.51	2295.50
AD5	There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	**SSCs**	**46**	**59.72**	**2747.00**
		Non-SSCs	54	42.65	2303.00
AD6	The government policies have prioritised societal benefits over environmental ones.	**SSCs**	**46**	**56.51**	**2599.50**
		Non-SSCs	54	45.38	2450.50

Note: **Bold** indicates the highest mean rank

Based on Table 4.21, residents from SSCs, namely Putrajaya and Cyberjaya, exhibit a higher mean rank across all 15 assessed criteria compared to residents from non-SSCs, Kuala Lumpur and Shah Alam. This trend can be attributed to the more advanced SSCs development in Putrajaya and Cyberjaya. Putrajaya, for instance, was established in 1999 as Malaysia's new administrative capital and designed as a smart garden city with extensive green spaces and integrated smart infrastructure (Lim, Woods and Koo, 2023). Furthermore, Putrajaya and Cyberjaya benefit from well-connected transport systems, including federal highways 29 and 30, the KLIA Express rail line, and RapidKL bus services, providing residents with accessible and efficient mobility options (Hong and Wong, 2017).

In contrast, Kuala Lumpur is still undergoing the implementation of its Smart City Master Plan 2021–2025, reflecting a city in transition rather than one fully realising SSC principles (Talib and Muhammad Taib, 2024). Additionally, cities like Kuala Lumpur continue to face challenges such as fragmented coordination among agencies and limited digital platform integration, which hamper their progress toward SSC objectives (Ministry of Housing and Local Government, 2019). These findings are supported by previous studies that highlight the more advanced infrastructure, governance, and service integration present in SSCs like Putrajaya and Cyberjaya compared to cities still in the developmental phase.

4.7.4 Mann-Whitney U Test on Type of Income

This section examines two groups of respondents categorised by type of income, namely with income (Employed (Full-time) / Employed (Part-time) / Self-employed / Others) and without income (Student / Retired).

Two hypotheses are formulated for this test as below:

Null hypothesis (H_0): If $p > 0.05$, there is no significant difference in city readiness between those with income and those without income.

Alternative hypothesis (H_1): If $p \leqslant 0.05$, there is a significant difference in city readiness between those with income and those without income.

Table 4.22: Mann-Whitney U Test on Income

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
AA4	I will involve in urban development projects in my current residential city that would lead to better outcomes for creating a smart sustainable city.	904.500	2984.500	-2.014	.044

Table 4.22 shows the Mann-Whitney U test outcomes for income, indicating that one criteria related to city readiness levels have p-values below 0.05. The findings imply that with and without income have significantly different perceptions of these readiness levels. Thus, the null hypothesis (H_0) is rejected for these four criteria.

Table 4.23: Mean Rank of Readiness Level of Cities for Becoming Smart Sustainable Cities across Income

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Type of Income	N	Mean Rank	Sum of Ranks
AA4	I will involve in urban development projects in my current residential city that would lead to better outcomes	With Income	64	46.63	2984.50
		Without Income	**36**	**57.38**	**2065.50**

Table 4.23 (Continued)

Code	Readiness Level of Cities for Becoming Smart Sustainable Cities	Type of Income	N	Mean Rank	Sum of Ranks
	for creating a smart sustainable city.				

Note: **Bold** indicates the highest mean rank

According to Table 4.23, those without income have a higher rank in AA4 = "I will involve in urban development projects in my current residential city that would lead to better outcomes for creating a smart sustainable city" than those with income. This suggests that individuals without income may be more inclined to engage in urban development initiatives, possibly due to a stronger sense of community involvement or a desire for improvements in their local environment. Alam and Siddiqui (2021) suggest that unemployed individuals often view SSCs as avenues for skill development and potential employment, making them more motivated to participate in initiatives that could lead to personal and community advancement, especially when policies are inclusive and participatory. Besides, students with higher computer proficiency are better positioned to benefit from smart city developments, suggesting that their perceptions of such initiatives are closely tied to their comfort and familiarity with digital tools and environments (Picatoste *et al.*, 2017). These would be consistent with the result obtained.

4.8 Summary of Chapter

This chapter provided a comprehensive discussion of the readiness level of SSCs and non-SSCs in Malaysia and the strategies to improve the city readiness level. A total of 113 responses were received. However, 13 sets of responses were discarded as not within the research scope. Thus, 100 responses were analysed using Cronbach's Alpha Reliability Test, Arithmetic Mean, Spearman's Correlation Test, Kruskal-Wallis Test, and Mann-Whitney U Test.

The results of Arithmetic Mean showed that for the readiness level, "Technology Aspects (AB)" was the most ready aspect while "Economic

Aspects (AC)" was the lowest readiness aspect in SSCs. For non-SSCs, "Human Aspects (AA)" was the most ready aspect and "Governance Aspects (AD)" ranked the lowest. For strategies, "Infrastructure Development (BC)" was the most effective strategy while "Financial Incentives and Subsidies (BB)" was the lowest rank. Apart from that, the results of Spearman's Correlation Test revealed that the higher levels of technological integration are linked to increased citizen participation in shaping SSC initiatives. Additionally, Kruskal-Wallis Test showed significant differences among age, educational level, income level, and ethnicity on the city readiness level. Lastly, Mann-Whitney U Test presented the significant differences between gender, marital status, residential state, and types of income.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary and conclusion of the entire study. It starts with a discussion of the accomplishment of the research objectives. Next, the contribution of this study to accelerate Malaysia's transition to SSC is presented. The limitations encountered during the research are then outlined, followed by recommendations for enhancing future studies.

5.2 Accomplishment of Research Objectives

The following sections present a summary of the accomplishments related to the three research objectives.

5.2.1 Objective 1: To compare the readiness levels of Smart Sustainable Cities and Non-Smart Sustainable Cities

The first objective of this study was achieved through the review of secondary sources, which four main criteria for measuring the readiness levels were identified, including Human Aspects, Technology Aspects, Economic Aspects, and Governance Aspects. These four criteria were then further divided into 21 sub-criteria to provide a detailed discussion of the different aspects within each area. Following this, an Arithmetic Mean analysis was applied to the data collected from the questionnaire surveys, allowing the readiness levels of both the four main criteria and the 21 sub-criteria to be ranked and presented in Table 4.3 and Table 4.4. Also, Spearman's Correlation test was adopted for the data collected.

For SSCs, the results showed that among the four main criteria, Technology Aspects (AB) had the highest level of readiness, followed by Human Aspects (AA) and Governance Aspects (AD). In contrast, Economic Aspects (AC) was identified as the lowest readiness level. As for non-SSCs, Human Aspects (AA) achieved the highest readiness level among the four main criteria with Technology Aspects (AB) and Economic Aspects (AC) following behind. Meanwhile, Governance Aspects (AD) recorded the lowest readiness level.

Moreover, the sub-criteria with the highest level of readiness in SSCs was AB4 = “The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city”. On the other hand, AC1 = “There is an efficient resource allocation in my current residential city” was the lowest readiness sub-criteria according to the respondents. Besides, in the context of non-SSCs, AA3 = “I am ready to use IT-based services and technologies in my current residential city” ranked the highest readiness while the lowest readiness level was AD3 = “There is an increasing of government’s capacity to use ICTs to meet community demands”.

In terms of Spearman’s Correlation Test, it uncovered that “I am ready to use IT-based services and technologies in my current residential city” (AA3) is the most significant criteria. The highest correlation spotted in the relationship between readiness levels and strategies to improve readiness levels was “There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city’s infrastructure” (AB1) and “Encourage citizen participation in urban planning and smart sustainable city initiatives” (BA2).

5.2.2 Objective 2: To identify strategies for improving the readiness level of cities to become Smart Sustainable Cities

The second research objective was achieved through a literature review and the collection of respondents’ perspectives on the strategies for improving the readiness level. The collected data were then analysed using the Arithmetic Mean. Table 4.5 and Table 4.6 presented the ranking of the 8 main strategies and 37 sub-strategies for improving the readiness level of cities to become SSCs correspondingly. Additionally, the Spearman’s Correlation test was applied to the collected data.

The result revealed that the most effective strategy is the Infrastructure Development (BC), followed by the Pilot and Scale Smart Solutions (BF), Secure Funding and Resources (BH), Education and Awareness Campaigns

(BA), Policy and Regulatory Frameworks (BD), Planning for Long-Term Sustainability (BG), and Comprehensive Data Strategy (BE). On the contrary, the lowest rank strategy from the respondents' perspectives was the Financial Incentives and Subsidies (BB).

In terms of sub-strategies, it was observed that BC5 = "Invest in modern infrastructure, such as smart grids and digital networks" was considered the most effective sub-strategy. In contrast, BB4 = "Offer non-monetary incentives, such as public-private partnerships (PPPs)" was viewed as the least effective among all the sub-strategies. Besides, Spearman's Correlation Test showed that "Organise campaigns to increase public awareness" (BA1) is the most outstanding strategy.

5.2.3 Objective 3: To assess the effect of sociodemographic factors on city readiness towards Smart Sustainable City

The third research objective was accomplished by applying the Kruskal-Wallis Test and Mann-Whitney U Test to analyse the significant differences in city readiness among respondents with varying sociodemographics. The sociodemographic factors included age, educational level, income level, ethnicity, gender, marital status, residential state, and type of income.

As revealed by Kruskal-Wallis Test, there was one significant difference between the age groups, which was AD2 = "There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation." For educational level, the medium educational level group was ranked highest for AA5 = "I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation" compared to the high and low educational groups. Furthermore, the B40 income group had the highest mean rank in "Economic Aspects (AC)" whereas the M40 income group exhibited higher mean ranks for "Governance Aspects (AD)". With regards to ethnicity, Malays consistently recorded the highest average rankings across different indicators of city readiness, particularly in Human Aspects (AA). On the other hand, Chinese respondents consistently achieved the lowest average rankings across nearly all city readiness indicators, especially in Governance Aspects (AD).

For the Mann-Whitney U Test, it demonstrated that males showed greater awareness of public initiatives (AA1), stronger perceptions of government innovation efforts (AD1), higher recognition of government use of ICTs (AD2), and greater confidence in government-citizen collaboration through technology (AD3) than females. Moreover, married respondents exhibited greater perceptions in terms of Governance Aspects (AD) when compared to single respondents. For the residential state, SSCs showed higher readiness across most of the aspects, particularly in Technology Aspects (AB) and Governance Aspects (AD). Last but not least, respondents without income were likely to involve in urban development projects in their current residential city than those with income.

5.3 Research Contributions

This study provides a comprehensive overview of city readiness (SSCs and non-SSCs) towards SSC in Malaysia by identifying key criteria for measuring the readiness level, which reflects the degree to which cities are prepared to transition into smart sustainable urban environments. Also, assessing the readiness levels of SSCs and non-SSCs in Malaysia helps to identify key focus areas for maintaining progress and accelerating the transition of cities toward becoming SSCs. The research highlights the strategies required to improve this readiness, emphasising the role of technological, infrastructural, and policy innovations. Additionally, the study explores the sociodemographic factors that influence the readiness of cities to adopt smart and sustainable practices, shedding light on how various population segments, urban conditions, and regional disparities play a role in shaping the transition.

The findings of this research are highly relevant to key Malaysian governmental departments, such as Jabatan Kerja Raya (JKR), which will assist in aligning public infrastructure projects with SSC principles, ensuring energy-efficient and sustainable developments. Besides, with insights into industry readiness, the Construction Industry Development Board (CIDB) can establish guidelines and incentives that encourage the construction sector to adopt smart technologies, ensuring that building practices align with SSC objectives. By leveraging the readiness assessment and proposed strategies, these departments can take targeted actions to accelerate Malaysia’s transition into a smart and sustainable urban future.

In addition, this research will incorporate comparative analysis of cities that have successfully implemented SSC initiatives, providing valuable insights into Malaysia’s urban development. For example, Singapore has established itself as a leading SSC through integrated digital governance, data-driven urban planning, and widespread adoption of smart mobility solutions like autonomous vehicles and an advanced public transport system. By comparing Malaysia’s current readiness with such global best practices, the study will highlight the gaps in infrastructure, policy frameworks, and technological adoption.

Moreover, by using Kruskal-Wallis Test and Mann-Whitney U Test, significant differences are identified across various sociodemographics. For example, citizens aged 21-30 years old as well as the low educational level, may have low readiness in certain aspects such as engaging with local government initiatives related to SSC transformation. Also, female and single citizens might not have a strong awareness of SSC. By knowing this, policymakers and urban planners can design more targeted strategies and inclusive policies that address the specific needs and barriers faced by different demographic groups, thereby enhancing overall engagement and readiness for SSC transformations.

Lastly, this study's findings contribute to the literature on SSC by assessing city readiness and strategies for improvement. Researchers can use this as a reference to explore SSC adoption in different national or regional contexts and identify key influencing factors. The study also highlights areas needing further research, such as sociodemographic impacts and governance roles in SSC initiatives. These insights help academics refine theories, develop frameworks, and advance Malaysia’s smart urban transformation.

5.4 Research Limitation

Despite the research contributions, this study also has limitations. This study was limited in its geographic scope, as it primarily focused on selected cities in Malaysia, which may not fully represent the readiness level of all urban areas in the country. Smaller towns and rural areas may have different challenges and levels of readiness that were not captured in this research. As a result, the findings and recommendations may be more applicable to metropolitan areas rather than a nationwide perspective.

Moreover, this study relied solely on a quantitative approach using questionnaires, which may limit the depth of insights gathered. In other words, the reliance on predefined questionnaire items may restrict respondents from expressing unique perspectives or concerns that could provide valuable insights into SSC development. While surveys provide measurable and generalizable data, they may not fully capture the complexities of city readiness, such as stakeholders' perspectives, policy challenges, and contextual barriers. Besides, self-reported responses may introduce biases, as knowledge of participants and perceptions of SSC initiatives can vary, affecting the accuracy of the results.

Lastly, while the study focused on assessing city readiness and identifying strategies to improve city readiness, it did not extensively evaluate the feasibility or effectiveness of these strategies in real-world implementation. The proposed strategies serve as a general framework, but their success depends on various factors such as governance structures, financial resources, and public engagement. Without a detailed examination of these influencing factors, the study does not provide a comprehensive roadmap for execution. Furthermore, the adaptability of these strategies may vary across different cities, as local challenges, policy environments, and technological capacities differ.

5.5 Research Recommendations

A few recommendations are made for further study to get beyond the aforementioned limitations. Firstly, future studies should consider adopting a mixed-methods approach by integrating qualitative methods, such as interviews or focus group discussions, to complement the quantitative findings. This approach would allow for a deeper exploration of stakeholder perspectives, policy barriers, and localised challenges that may not be fully captured through structured questionnaires. Next, conducting case studies on cities that have successfully implemented SSC initiatives could also provide real-world insights and best practices for implementation in the Malaysian context.

Thirdly, future research should expand the geographic scope by incorporating a wider range of urban areas, including smaller towns and rural regions, to gain a more comprehensive understanding of city readiness towards SSC across Malaysia. A broader analysis will help capture diverse challenges that may influence SSC implementation. Comparative studies between metropolitan and non-metropolitan areas can also provide valuable insights into tailored strategies for different urban contexts. Lastly, further research should focus on evaluating the feasibility and effectiveness of the identified strategies for improving city readiness towards SSC. It is needed to test and refine the strategies through pilot programs, case studies, or stakeholder engagement to ensure their practical applicability in achieving SSC transformation.

5.6 Summary of Chapter

This chapter has provided a summary of the research background, aim, and objectives. Additionally, all three research objectives have been successfully accomplished. The study's contributions were then outlined. Lastly, the study's limitations were discussed, and recommendations were made to guide future research.

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APPENDICES

Appendix A: Questionnaire

Dear Sir/Madam,

I am Too Yu Heng, a final year undergraduate student who is pursuing Bachelor of Science (Honours) Quantity Surveying in Universiti Tunku Abdul Rahman (UTAR). I am currently conducting a survey for my final year project entitled "Smart Sustainable City Readiness in Malaysia" as a partial fulfilment of the programme structure. The purpose of this research is to evaluate the readiness level of Malaysian cities towards a Smart Sustainable City.

This questionnaire consists of THREE (3) sections and it would take approximately 10 to 15 minutes to complete. I would like to express my appreciation for your participation in this survey and I believe that your professionalism and experiences will significantly contribute to the success of this research. Your responses given for this survey will be kept confidential and remained anonymous. The responses will be solely used for academic purposes.

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

Student name: Too Yu Heng
Contact number: 018-5756261
E-mail: too021115@1utar.my

Thank you for your participation and precious time.

Smart sustainable city readiness refers to a city's ability to adopt and integrate advanced technologies and sustainable practices to enhance urban living while ensuring environmental and social balance.

Section A: Demographic Section

Please tick (√) in the relevant box.

1. What is your gender?
    - Male
    - Female

2. What is your age group?
    - 20 years old and below
    - 21-30 years old
    - 31-40 years old
    - 41-50 years old
    - 51-60 years old
    - 61 years old and above

3. What is your highest educational level?
    - High School
    - Sijil Pelajaran Malaysia (SPM) / GCE O-Level / equivalent
    - Sijil Tinggi Persekolahan Malaysia (STPM) / GCE A-Level / equivalent
    - Foundation
    - Diploma
    - Bachelor’s Degree
    - Master’s Degree
    - PhD
    - Other, please specify __________

4. What is your monthly household income?
    - Less than RM2,560
    - RM2,560 – RM3,439

- RM3,440 – RM4,309
- RM4,310 – RM5,249
- RM5,250 – RM6,339
- RM6,340 – RM7,689
- RM7,690 – RM9,449
- RM9,450 – RM11,819
- RM11,820 – RM15,869
- RM15,870 and Above

5. What is your marital status?
   - Single
   - Married
   - Divorced
   - Widowed
   - Separated

6. Where is your current residential state?
   - Kuala Lumpur
   - Putrajaya
   - Cyberjaya
   - Shah Alam
   - Other, please specify __________

7. What is your residential postcode?

8. What is your ethnicity?
   - Malay
   - Chinese
   - Indian
   - Other, please specify __________

9. What is your occupation?
   - Student

- Employed (Full-time)
- Employed (Part-time)
- Self-employed
- Unemployed
- Retired
- Other, please specify ___________

Section B: Readiness Level of Cities for Becoming Smart Sustainable Cities

This section contains a list of criteria for measuring city readiness towards smart sustainable city. Based on your current residential state, rank each of the following questions from scale 1 (Strongly Disagree) to 5 (Strongly Agree) by ticking (√) at the appropriate options about your opinions on the city readiness.

Criteria for measuring City Readiness towards Smart Sustainable City	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
Human Aspects					
I am aware of public projects and initiatives for transforming my current residential city into a smart sustainable city.					
I am willing to participate in discussions or planning activities related to my current residential city's transformation into					

a smart sustainable city.	
I am ready to use IT-based services and technologies in my current residential city.	
I will involve in urban development projects in my current residential city that would lead to better outcomes for creating a smart sustainable city.	
I am likely to provide feedback or engage with local government initiatives related to the smart sustainable city transformation.	
Technology Aspects	
There is an increasing use of smart technologies, such as Internet of Things and robotics, within my current residential city's infrastructure.	

There is a seamless sharing of data across different sectors (e.g., transport, healthcare, energy).	
There is an increasing use of blockchain technology which can improve the transparency, security, and efficiency of processes in my current residential city.	
The sustainable and smart mobility options, such as well-connected public transport or bike-sharing systems, are widely available in my current residential city.	
There is an increasing use of technologies such as machine learning which can improve the service	

efficiency of the public transport.	
Economic Aspects	
There is an efficient resource allocation in my current residential city.	
There is an increasing use of circular economy practices, such as recycling and renewable energy.	
There are sufficient initiatives that focus on reducing waste, emissions, and resource input make urban areas more sustainable.	
There are environmental considerations taken into account while implementing smart sustainable city programs which can lead to long-term cost savings in my current residential city	
There are sufficient initiatives that align	

with global Sustainable Development Goals (SDGs) to make my current residential city more sustainable and resilient.	
Government Aspects	
My current residential city's government is actively working to innovate and provide effective solutions to local problems.	
There is sufficient vision, policies, initiatives, and governance in preparing my current residential city for smart sustainable city transformation.	
There is an increasing of government's capacity to use ICTs to meet community demands.	

The local government effectively collaborates with citizens through technology to address urban issues and promote my current residential city’s growth.	
There is a continuous enhancement of e-participation initiatives to maintain the public satisfaction.	
The government policies have prioritised societal benefits over environmental ones.	

<u>Section C: Strategies to Improve City Readiness towards Smart Sustainable City</u>

This section contains a list of strategies to improve city readiness towards smart sustainable city. Rank each of the following questions from scale 1 (Strongly Disagree) to 5 (Strongly Agree) by ticking (√) at the appropriate options about your opinions on the strategies to improve city readiness.

Strategies to improve city readiness towards smart sustaibable city	**Strongly Disagree 1**	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
<u>Education and Awareness Campaigns</u>					
Organise campaigns to increase public awareness.					
Encourage citizen participation in urban planning and smart sustainable city initiatives.					
Utilise social networking services (e.g. Facebook) to increase public awareness about smart sustainable city and engaging citizens.					
Evaluating public awareness and understanding of					

smart sustainable city.	
Implement awareness initiatives. For example, Change Readiness Index can help to assess the city's readiness to transform into a smart sustainable city.	
Financial Incentives and Subsidies	
Provide government grants and subsidies to drive and accelerate smart sustainable city development.	
Offer financial incentives, such as lower energy bills during off-peak hours, can increase citizen participation in smart sustainable city initiatives.	
Provide subsidies to encourage companies and individuals to invest	

in sustainable infrastructure for smart sustainable city development.	
Offer non-monetary incentives, such as public-private partnerships (PPPs)	
Create digital platforms (e.g. Digital Social Market (DSM)) to motivate city residents to adopt sustainable practices.	
Provide non-cash rewards, such as redeemable tokens for sustainable actions, encourages residents to engage in smart sustainable city initiatives.	
Infrastructure Development	
Enhance the infrastructure in the city (e.g. water supply, sewerage and power).	
Enhance public transport	

connections to minimise traffic congestion.	
Improve technologies implementation such as Internet of Things and intelligent traffic systems.	
Upgrade highways and roads with smart technology.	
Invest in modern infrastructure, such as smart grids and digital networks.	
Upgrade existing infrastructure to integrate sustainable practices should be a priority for local governments.	
Policy and regulatory frameworks	
Enact strong policies and regulations for guiding the transition to a smart sustainable city.	
Foster collaboration between local government and	

various stakeholders, such as businesses and communities, can ensure effective implementation of smart sustainable city policies.
Implement national policies that prioritise urban sustainability.
Establish policies that focus on smart mobility and transportation management
Allocate sufficient funding by government to promote smart sustainable initiatives.
Implement strong policies to support investment in 5G networks and the deployment of Internet of Things sensors across the city.
Comprehensive Data Strategy

Create a centralised data platform that integrates information from various city services to improve decision-making in urban management.
Ensure data privacy and enforce ethical policies to increase citizen trust
Leverage data analytics and Artificial Intelligence to optimise traffic congestion and energy usage.
Standardise governmental portal for better data disclosure and minimise conflicts.
Pilot and Scale Smart Solutions
Start with small-scale pilot projects to test smart sustainable city technologies before full implementation.

Scale successful pilot projects across the city, customising them to meet the specific needs of each area.	
Continuously monitoring and adapting smart sustainable city initiatives based on feedbacks to ensure their long-term success.	
Evaluating smart sustainable city projects regularly to ensure the city's technological advancements up to date.	
Planning for Long-Term Sustainability	
Integrating smart sustainable city initiatives with urban planning to achieve long-term sustainability and liveability in the city.	

Focus smart sustainable city solutions on enhancing resilience to environmental, economic, and social challenges.
Create a flexible policy framework to address evolving urban needs as part of the smart sustainable city transformation.
Secure Funding and Resources
Explore diverse funding sources, such as government grants, private investments, and international collaborations to support smart sustainable city projects.
Prioritise budget allocation to secure essential resources for high-impact project.
Adopt a balanced approach for funding

innovation and sustainability.	