THE PROSPECT OF SMART CITIES IN SOCIETY: THE IMPERATIVE FOR POLICY ENHANCEMENT

By

JOOYEOL MAENG

Dissertation

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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IN PUBLIC MANAGEMENT

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Committee in charge:

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The Prospect of Smart Cities in Society: The Imperative for Policy Enhancement

By

Jooyeol MAENG

Abstract

In Chapter 1, the purpose of study is to explore prominent smart cities such as Amsterdam, Barcelona, London, and New York, as well as an abandoned plan in Toronto, and to identify those needing enhancement. For smart cities requiring improvement, this study examines smart city initiatives in South Korea, including U-City, Songdo, and Sejong. The study aims to offer insights for South Korea's smart city policies through in-depth interviews based on perceptions of experts, practitioners, and citizens to explore factors influencing sustainable development in South Korea. The analysis from the in-depth interviews is structured into four parts: Impact of Smart Cities on Society, Growth of Smart Cities in Society, Role of Local Government in Sustainable Smart Cities, Prospects of Smart Cities. The results of this study identify key factors influencing citizens' awareness and the development of smart cities, including technical development, economic benefits, city brand value, and corporate engagement. The study also finds government support and the necessity of policies are crucial for the better development of smart cities in society and quality of life.

In Chapter 2, this study aims to inform policy formulation and adjustments for smart cities in South Korea by examining citizens' perceptions and identifying factors influencing sustainable smart city growth. The study comprises four parts: Impact on Society, Growth in Society, Role of Local Government, Prospects of Smart Cities. Data is collected through an online survey and analyzed using factor analysis, ANOVA, and regression analysis. This study highlights how user-centered technical support, support from central and local government significantly influence citizens' perceptions. It emphasizes that local governments play a crucial role in fostering sustainable smart cities by encouraging citizen participation and effectively managing and collaborating with stakeholders. Additionally, the study identifies promotional strategy, public services, economic, social, and environmental factors as influential to the prospects of smart cities.

In Chapter 3, this study aims to provide insights for policy formulation and adjustments concerning living labs in South Korea by examining citizens' perceptions and determining factors influencing citizen participation living labs' activation. It is structured into five parts

addressing various questions: Understanding of Living Labs, Impact on Society, Growth in Society, Role of Local Government, Future Outlook. Data is collected through an online survey and analyzed using factor analysis, ANOVA, and regression analysis. Through multiple regression analysis, this study identifies factors influencing citizens' attitudes and satisfaction towards living labs. These factors include real-life conditions, locality, environmental impact, technical support, expert participation, and local government policy support. Citizens prioritize living labs that focus enhancing quality of life and addressing real-life conditions, while also preferring technologically advanced labs with expert validation and stable local government support.

The study offers policy and managerial implications for prioritizing citizens' attitudes, satisfaction, and participation intentions in smart cities and living labs. It stresses the need for appropriate policy adjustments to meet citizen expectations and promote the sustainable development and growth of smart cities and living labs.

Dedicated to

my family

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filled with miracles, and my family is one of the greatest among them. I am indescribably grateful for the priceless gift of my wife, Youngwon, and my sons, Seongju and Hyeonkyu. Most importantly, I recognize that everything has been by God’s grace. Thank you, LORD.

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CHAPTER 1

EXPLORING THE DETERMINANTS OF SMART CITY IMPLEMENTATION: UNRAVELING KEY FACTORS AND POLICY IMPLICATIONS IN SOUTH KOREA

Chapter 1

Exploring the Determinants of Smart City Implementation: Unraveling Key Factors and Policy Implications in South Korea

By

Jooyeol MAENG

Abstract

The purpose of this study is to explore prominent smart cities such as Amsterdam, Barcelona, London, and New York, as well as an abandoned plan in Toronto, and to identify those needing enhancement. For smart cities requiring improvement, this study examines smart city initiatives in South Korea, including U-City, Songdo, and Sejong. Furthermore, this study aims to offer insights for policy formulation and adjustments related to smart cities in South Korea through in-depth interviews based on perceptions of experts, practitioners, and citizens. This study specifically investigates experts, practitioners, citizens' awareness of smart cities and analyzes the factors influencing the development of sustainable smart cities. By selecting experts in the field of smart cities and citizens residing in smart cities, the content of in-depth interviews is structured into four parts (Study 1 ~ 4) to examine: i) perceptions of the impact of smart cities on society, ii) perceptions of the growth of smart cities in society, iii) perceptions of the role of local government in the growth of sustainable smart cities, and iv) perceptions of the prospects of smart cities. This study gathers insights through in-depth interviews with selected experts and citizens to explore these key aspects related to smart city development. After exploring key aspects for the implementation of smart cities through case studies, this study identified the following aspects based on qualitative research. First, regarding factors influencing citizens' awareness of smart cities in Study 1, both experts and citizens identified several key factors that would influence smart cities. These factors include technical development, economic benefits, city brand value, and corporate engagement or participation. Experts emphasized smart city-related experience, public service quality, institutional improvements, and open interactions as crucial factors influencing citizens' awareness of smart cities. On the other hand, citizens considered government support to be an important aspect in shaping their awareness of smart cities. Secondly, regarding factors influencing the development of smart cities in Study 2, both experts and citizens agree that user-centered technical support, government backing, corporate engagement, and local government support are influential factors in the development of smart cities. Thirdly, regarding the preferred role of local government in the growth of smart cities in Study 3, both experts and citizens agree on the importance of efficient management

and operation, as well as active collaboration with stakeholders, as key roles of local government. Citizens also emphasized the need for more active promotional activities by local governments in fostering the growth of smart cities. This result indicates alignment between the perceptions of experts and citizens regarding the role of local governments in the growth of smart cities. However, it also suggests that citizens perceive local governments' promotional efforts as insufficient. Lastly, regarding the prospects for smart cities in Study 4, both experts and citizens commonly highlighted factors such as driving forces, expansion of public services, economic value, social value, and environmental value as influential in shaping the future prospects of smart cities. Citizens particularly emphasized the importance of government and local governments support as key driving forces for the future prospects of smart cities. This result highlights the shared recognition among both experts and citizens regarding the significant impact of driving forces, expansion of public services, economic value, social value, and environmental value on the prospects of smart cities. Additionally, citizens perceive that continuous support from the government and local governments is essential for the bright prospects of smart cities. This study provides important policy and managerial implications that are crucial for understanding citizens' attitudes, the role of local government, and the prospects for smart cities. These implications are essential for guiding proper preparations and amendments of public policy.

Keywords: Smart City, Quality of Life, Open Interaction, User-Centered Technical Support, Social value, Environmental Value, Sustainability, Role of Local Government

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I. Introduction

In light of the ongoing 4th Industrial Revolution, smart cities have emerged as a focal point for numerous countries, presenting an innovative approach to address diverse urban challenges through the utilization of cutting-edge ICT technologies, including IoT, cloud computing, big data, and mobile solutions. As projections indicate that 70% of the global population will reside in urban areas by 2050, the integration of ICT-based innovations becomes pivotal in confronting pressing urban issues (UN DESA, 2022). These challenges span a spectrum, ranging from a scarcity of affordable housing and inadequate infrastructure to constrained open spaces, heightened air pollution, and escalating concerns regarding climate change (Manville et al., 2014).

According to the European Commission (2020), smart cities are characterized as urban areas utilizing technological solutions to enhance the management and efficiency of the urban environment and it denotes a city where traditional networks and services are rendered more efficient through the incorporation of digital and telecommunication technologies for the benefit of its residents and businesses. A smart city is one that establishes a sustainable urban environment through new ICT technology, enhancing citizens' quality of life through competitiveness and innovation, and fostering interconnectedness among people, information, and the city (Bakici et al., 2013).

While smart cities in Europe and the United States aim to enhance citizens' quality of life through increased democratic private participation, Asian cities, including China, India, and South Korea, are initially prioritizing the construction of smart city plans centered on the public sector which approach is primarily driven as a national policy project based on the development of advanced ICT technologies (Kim et al., 2018). The initial divergence in smart city approaches, with European cities emphasizing citizen participation, has led to successful models like Amsterdam, Barcelona and London (Kim, 2020). These cities integrate cutting-edge technologies to connect people, information, and cities, fostering a high quality of life through an innovative platform that encourages cooperative relationships among government, businesses, and citizens (Bakici et al., 2013). South Korea also showcases instances including Seoul Smart City, Songdo Smart City and Sejong Smart City highlighting the potential of smart cities leveraging world-class ICT technology. Seoul Smart City offers public services enabling citizens and tourists to conveniently utilize various apps on buses and bus stops through free Wi-Fi and similarly, Songdo Smart City prioritizes safety through data utilization via public

CCTV and sensors, while Sejong Smart City enhances citizens' transportation efficiency by employing advanced systems, including AI traffic lights and demand-responsive buses. (Seong et al., 2016; Ahn et al., 2019; Jeong, 2021).

Despite the success of smart cities in South Korea in expanding public infrastructure through the integration of advanced ICT technologies, the top-down project promotion by the central government, without due consideration for local citizen needs, has resulted in decreased citizen satisfaction in terms of citizen participation. (Ministry of Land, Infrastructure and Transport, 2014). Lately, smart city governance challenges, including insufficient citizen awareness and participation, as well as the absence of a comprehensive promotion system involving government, local entities, private firms, and citizens, are regarded as crucial factors in establishing a citizen-centered innovation platform, so policy alternatives, such as living labs, are actively endorsed by local governments to address these issues. (Jang, 2018; Lee & Han, 2019). In recent times, European city authorities have asserted that citizens, particularly those considered "smart", are just as crucial to the success of smart city initiatives as data and technology and it is imperative to ensure that citizens are convinced of the benefits and security these initiatives provide to them (Morozov & Bria, 2018).

In South Korea, the absence of suitable policy preparations regarding citizen awareness and participation in smart cities has been identified as a hindrance to the growth of smart cities. Given these considerations, this study aims to examine the factors influencing citizen awareness for the growth of sustainable smart cities. Previous studies have primarily utilized exploratory research analysis to examine theoretical definitions, concepts, case studies, and the peripheral application of smart cities. By conducting in-depth interviews with field researchers, practitioners involved in policy decision-making and implementation, as well as citizens of smart cities, this study expects to provide insights for the better development of smart cities in South Korea. Such interviews can provide valuable insights into the factors influencing citizen awareness and the success of smart city initiatives. The significance of this study lies in its comparative and analytical approach to the perceptions obtained through interviews. By engaging in-depth discussions with researchers, practitioners, and citizens on factors influencing citizen awareness of smart cities, the development and prospects of smart cities, as well as the role of local governments in smart city development, this research provides valuable insights into the subject matter.

This is particularly evident in the analysis of policies related to sustainable smart cities, and the examination of determinants that can develop smart cities and address policy concerns

from the perspective of researchers, practitioners in charge, and citizens. This study specifically investigates the following questions through in-depth interviews with the groups deeply involved in smart cities: i) What factors do researchers, practitioners and citizens perceive as having a positive impact on citizens' attitudes toward smart cities? ii) What factors do researchers, practitioners and citizens perceive as having a positive impact on quality of life in smart cities? iii) What factors do researchers, practitioners and citizens perceive as having a positive impact on the development of smart cities? iv) Which role of local governments do researchers, practitioners and citizens perceive as having a positive impact on the growth of smart cities? v) What factors do researchers, practitioners and citizens perceive as having a positive impact on the prospect of smart cities?

Hence, the objective of this study is to compare and analyze the characteristics of smart cities that have been successfully implemented and promoted by various cities worldwide. Additionally, this study aims to explore and analyze the underlying causes of the issue by examining smart city initiatives that require improvement and enhancement. Furthermore, this study aims to understand the current status of smart cities in Korea by conducting in-depth interviews with experts in the field of smart cities including researchers and practitioners as well as citizens who reside in smart cities. Moreover, this study aims to identify the determining factors that can rejuvenate the growth of sustainable smart cities. In other words, this study aims to present key concepts and influential factors essential for the realization of smart cities based on a triangular method encompassing literature reviews, review of smart cities, and in-depth interviews. The results of this study is to identify key factors that require development in smart cities and serve as a stepping stone for the quantitative analysis in Chapter 2. The results of this study are anticipated to offer managerial and policy implications, providing recommendations for improved citizen relationship management.

II. Literature Review

2.1. Definition of Smart City

Despite the significant interest and investment in smart cities in recent years, with numerous initiatives and projects underway worldwide, there remains no universally agreed definition of smart cities (Albino et al., 2015), resulting in continued ambiguity surrounding the concept (Ramaprasad et al., 2017). There are over 200 related concepts, defining smart cities in various ways, from technology development to the construction of physical

infrastructure and the enhancement of urban sustainability (Land and Housing Research Institute, 2018). This lack of a clear definition poses challenges for policymakers, city planners, and stakeholders involved in implementing and advancing smart city initiatives (Gracias et al., 2023).

Numerous studies have tackled the challenging task of defining a smart city, with early efforts emphasizing the application of information technology to manage various urban functions. More recent research has broadened the scope to encompass outcomes and perspectives such as sustainability, quality of life, and citizen services (Washburn et al., 2009; Hara et al., 2016; Ahvenniemi et al., 2017). In the realm of information technology, many definitions of smart cities focus solely on the electronic services provided to citizens, often overlooking broader outcomes such as sustainability, quality of life, equity, livability, and resilience, conversely, in urban-related disciplines, sustainability and quality of life have been central considerations across most dimensions of smart city discourse, although electronic means are not always explicitly included in these definitions (Ramaprasad et al., 2017). Murgante and Borruso (2013) caution that a focus solely on improving technological systems, which may quickly become outdated, risks neglecting the crucial aspects of sustainability.

Sustainability-oriented definitions of smart cities emphasize aspects such as the environment, economy, mobility, people, quality of life, and governance performance, whereas non-sustainability-oriented definitions tend to focus on areas like transport efficiency, education, and administration (Toli & Murtagh, 2020). These definitions perceive smart cities as possessing a unique intellectual capability that addresses innovative socio-technical and socio-economic growth aspects (Zygiaris, 2013). Consequently, the concept of smartness in smart cities extends beyond technological operations to encompass social and human dimensions (Siemens, 2017). While the overarching goal of smart cities is to enhance quality of life, operational efficiency, and competitiveness, they must also address the needs of present and future generations across economic, social, environmental, and cultural dimensions (International Telecommunication Union, 2016). Microsoft (2018) characterizes smart cities as those leveraging ICT to enhance citizen services such as energy, water, public safety, and transportation, thereby promoting the health, sustainability, resilience, and safety of urban environments. Consequently, smart cities aim to foster a harmonious relationship between citizens' quality of life and a sustainable, environmentally friendly lifestyle (Hitachi, 2012). The UK advocates for smart cities to achieve efficient integration of physical, digital, and human systems within their infrastructure, fostering a sustainable, prosperous, and inclusive

future for their inhabitants (BSI, 2013). In essence, smart cities aim to enhance urban services and management for citizens, fostering socially advanced environments through innovative technologies, all with the overarching goal of sustainable urban growth and improved quality of life. As a result, definitions of smart cities that embrace the environmental dimension of sustainability often encompass the social dimension as well. Table 1 below illustrates these characteristics of smart cities through clear definitions.

Table 1. Definitions of Smart City that Foster Values of Sustainability and Quality of Life

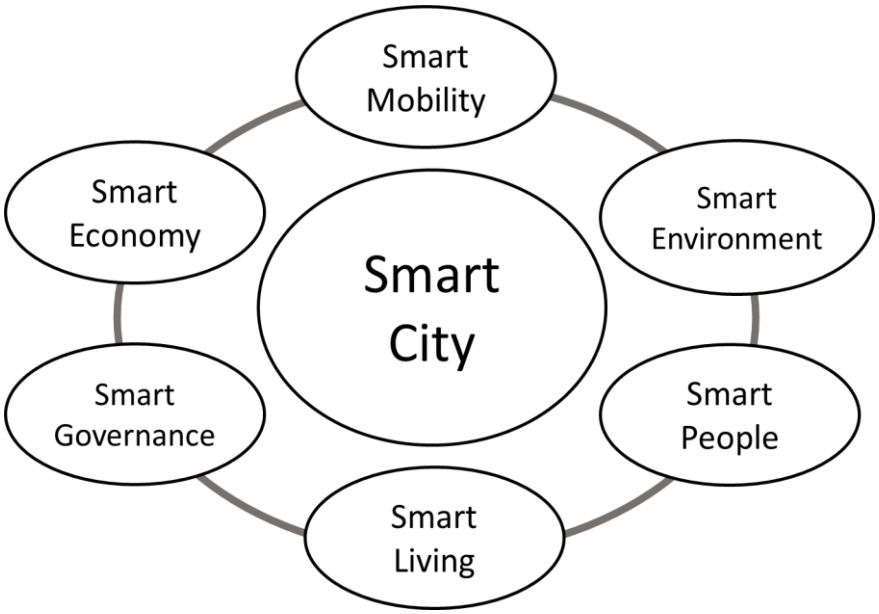
Reference	Definition
Angelakoglou et al (2019)	Smart and sustainable cities are expected to form a cornerstone for achieving resource efficiency and sustainability worldwide.
Alsamhi et al (2019)	Cities that contain intelligent things which can intelligently automatically and collaboratively enhance life quality, save people's lives, and act as sustainable resource ecosystems.
Singh et al (2022)	A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, the efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of the present and future generations concerning economic, social and environmental aspects.
Ullah et al (2020)	Smart cities are aimed to efficiently manage growing urbanization, energy consumption, maintain a green environment, improve economic and living standards of their citizens and raise people's capabilities to efficiently use modern information and communication technology (ICT).
Ismagilova et al (2019)	Smart cities employ information and communication technologies to improve: the quality of life for its citizens, local economy, transport, traffic management and interaction with government.
Xie et al (2019)	A smart city is a system that enhances human and social capital wisely using and interacting with natural and economic resources via technology-based solutions and innovations to address public issues and efficiently achieve sustainable development and high quality of life.
Silva et al (2018)	Smart city is an urban environment that utilizes ICT and other related technologies to enhance performance efficiency of regular city operations and quality of services (QoS) provided to urban citizens.
Shoaib & Shamsi (2019)	A smart city utilizes urban informatics and technologies for providing city services on a larger scale. It offers improved quality of life and a variety of innovative services such as energy, transport, healthcare, etc.
Attaran et al (2022)	In smart city architecture, information and communication technologies are used to improve living standards and its management by citizens and government.
Singh & Singla (2021)	Smart City is Use/Innovation of Technology/ICT coupled with favorable government policies that promote the development of infrastructure, ease of doing business and citizen engagement leading to sustainable economic growth and citizen satisfaction through improved quality of life.
Haque et al (2022)	Smart city is the idea of creating a sustainable living environment along with state-of-the-art technology (ICT) integration. A smart city is a self-containing city that focuses on people's QoL above everything else.
Tascikaraoglu (2018)	A smart city has been generally defined as a developed urban area that uses information and technology (ICT), human capital and social capital in order to promote sustainable socio-economic growth and a high quality of life.

De Nicola & Villani (2021)	A smart city is a complex cyber-socio-technical system where human, cyber artifacts, and technical systems interact together to the purpose of achieving a goal related to the quality of life in urban areas.
Akpinar (2019)	A set of instruments across many scales that are connected through multiple networks and provide continuous data regarding people and environment in support of decisions about the physical and social form of the city.
Dashkevych & Portnov (2022)	Smart cities are cities that balance economic, environmental, and societal advances to improve the wellbeing of residents through a widespread introduction of ICT and other technological tools.
International Organization for Standardization (2019)	City that increases the pace at which it provides social, economic, and environmental sustainability outcomes and responds to challenges such as climate change, rapid population growth, and political and economic instability by fundamentally improving how it engages society, applies collaborative leadership methods, works across disciplines and city systems, and uses data information and modern technologies to deliver better city (residents, businesses, visitors), now and for the foreseeable future, without unfair disadvantage of others or degradation of the natural environment.
Yin et al (2015)	A smart city is a system integration of technological infrastructure that relies on advanced data processing with the goals of making city governance more efficient, citizens happier, businesses more prosperous and the environment more sustainable.
Caragliu & Del Bo (2016)	A city is smart if investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.
Capdevila & Zarlenga (2015)	A smart city is the concept could be briefly described as cities that use information and communication technologies in order to increase the quality of life of their inhabitants while contributing to a sustainable development.
Sujata et al (2016)	Smart city is a futuristic approach to alleviate obstacles triggered by ever-increasing population and fast urbanization which is going to benefit the governments as well as the masses. Smart cities are an endeavor to make cities more efficient, sustainable and livable.
Meijer et al (2016)	A smart city is a utopian vision of a city that produces wealth, sustainability, and well-being by using technologies to tackle wicked problems.
Mora & Bolici (2016)	Smart cities are urban areas in which information and communication technologies are used to solve their specific problems and support their sustainable development in social, economic and/or environmental terms.
Ministry of Land, Infrastructure and Transport (2017)	The Smart City Law of South Korea defines a smart city as follows: smart cities, which are cities where technology-based urban environments, various public services related to citizen life, and social system construction are closely connected, are built to improve the competitiveness of the city and the quality of life of citizens compared to existing cities.

Undoubtedly, a smart city represents a multidisciplinary concept, encompassing not just infrastructure rooted in information and communication technologies, but also the city's ability to effectively manage information and resources to enhance the quality of life for its citizens. Various frameworks further elaborate on these concepts, delineating critical elements within smart cities and proposing interrelationships among these elements. For example, Giffinger et al. (2007) apply a smart city framework with key components including smart economy (competitiveness, innovative spirit, productivity), smart people (social and human capital, creativity, participation in public life), smart governance (participation in decision-making, public and social service, transparent governance), smart mobility (transport and ICT, local

accessibility, sustainable, innovative and safe transport system), smart environment (natural resources, environmental protection, sustainable resource management), and smart living (quality of life, health conditions, housing quality, education facilities, social cohesion) for smart cities. Figure 1 illustrates Giffinger's smart city framework, comprising six components and their associated properties essential for establishing a sustainable smart city.

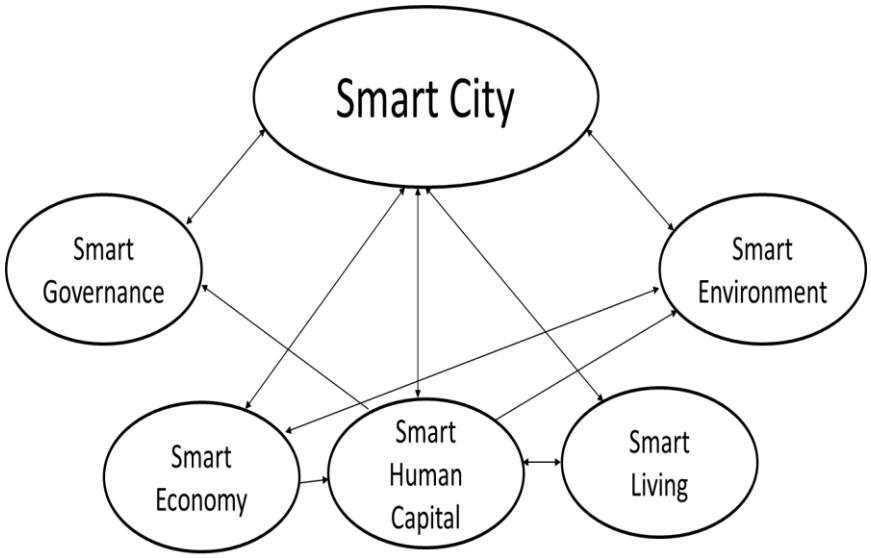
Figure 1. Key Components of Smart City (Proposed by Giffinger et al, 2007)



Source: Six characteristics of smart city adopted from Giffinger et al. (2007)

Similarly, Lombardi et al. (2012) propose the framework's components that are most relevant when evaluating a sustainable smart city including smart governance (related to participation), smart human capital (related to people), smart environment (related to natural resources), smart living (related to the quality of life), and smart economy (related to competitiveness). According to Lombardi et al. (2012), smart economy and smart environment are the direct causes of the relationship to percentage of citizens engaged in environmental and sustainable oriented activities, smart governance, smart human capital and smart living are connected to activities related to the participation in lifelong learning. Figure 2 depicts Lombardi's smart city framework, featuring five components and their respective properties essential for assessing a sustainable smart city.

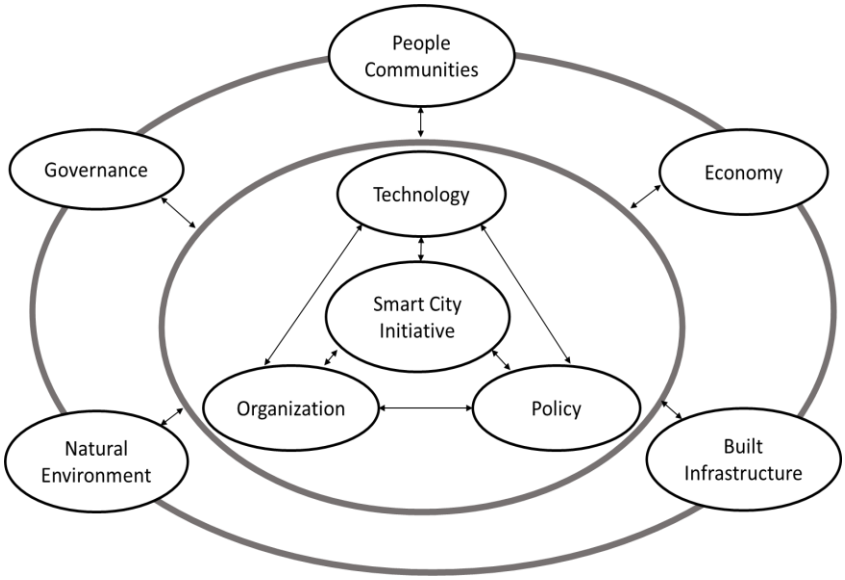
Figure 2. Key Components of Smart City (Proposed by Lombardi et al., 2012)



Source: Five characteristics of smart city adopted from Lombardi et al. (2012)

Chourabi et al. (2012) introduce a comprehensive framework outlining key components essential for understanding the relative success of various smart city initiatives. This framework encompasses organization, technology, and policy as drivers of smart cities, along with governance, people and communities, economy, built infrastructure, and natural environment as domains and desired outcomes. Figure 3 illustrates Chourabi's smart city framework, elucidating the components influencing smart city initiatives and their interrelationships.

Figure 3. Key Components of Smart City Initiatives Framework (Proposed by Chourabi et al., 2012)



Source: Smart City Initiative Framework by Chourabi et al. (2012)

In conclusion, drawing from the multitude of definitions and conceptual frameworks discussed, smart cities can be understood as leveraging digital technologies, communication tools, and data analytics to establish an efficient and effective service ecosystem. This ecosystem aims to enhance quality of life and foster social sustainability through citizen participation in governance, facilitated by supportive government policies.

2.2. Development of Smart City

2.2.1. Development of Smart City in Foreign Countries

Many cities worldwide, spanning European nations, the United States, China, India, and other Asian countries, are embracing smart city initiatives as a national strategy. These initiatives aim to address urban challenges stemming from rapid population growth, mitigate the effects of climate change, and establish new economic drivers to secure advantages in the era of the Fourth Industrial Revolution.

Smart cities in Europe and the United States can be found in new urbanism and smart growth resulting from it which has the character of a grassroots democratic movement in the late 1980s that sought to reintegrate living components such as housing, work, shopping, and rest in a pedestrian-friendly manner (Vanolo, 2014; Hollands, 2020). Europe and the United States provide a variety of services that combine culture and art with the goal of building an eco-friendly city through optimal use and efficient management of existing urban infrastructure for improving the quality of life of citizens through private rather than public participation (UN Economic and Social Council, 2016). Meanwhile, most developing countries have been pursuing smart city strategies to strengthen national competitiveness in energy and environment and expand infrastructure, and achieve economic growth through the combination of urban space and technology based on the 4th Industrial Revolution, mainly focusing on the public sector rather than the private sector (Vanolo, 2014; Lee & Han, 2019; Choi, et al., 2020).

Since the EU announced the Smart City and Community Innovation Partnership Strategy Implementation Plan in 2013, the European Commission has been promoting smart city construction projects, including promoting effective energy policies and solving transportation problems, and has been achieving successful results (Kim et al., 2018). In particular, the city of Amsterdam, which aims to consume eco-friendly energy in preparation for climate change, has formed more than 70 partnerships with businesses, authorities, research institutes, and

citizens, including CISCO and IBM, to focus on major themes such as living, working, mobility, public facilities, and open data (Amsterdam Smart City, 2013). Barcelona, a city of people, dedicated to improving quality of life and fostering economic progress, also provides the necessary legal framework for private-public partnerships to take root among stakeholders (Ajuntament de Barcelona, 2014). It demonstrates collaboration, which is the key to the Barcelona's smart city initiative, where each partner operates independently and their activities meet the aims of the smart city venture (Bakici et al., 2013).

The United States is actively implementing policies to address various urban challenges, including climate change response, education, infrastructure development, transportation, and taxation, for instance, New York City has adopted a local strategy that includes a well-defined digital approach tailored to local resources, priorities, and requirements (Angelidou, 2014). As part of this strategy, the city engages both private and public stakeholders, such as residents, city officials, and technology experts, to gather insights and suggestions for the advancement of New York's digital infrastructure, often taking place through online platforms where stakeholders can contribute ideas and participate in decision-making processes (The City of New York, 2011).

Asian countries like China and India have prioritized smart city development to address pressing urban challenges stemming from rapid urbanization, including environmental pollution, traffic congestion, housing shortages, and inadequate infrastructure (Kim, 2020). These nations have significantly increased their investments in urban development and infrastructure to boost national competitiveness and unlike Western advanced economies, which concentrate on energy, environment, and urban services improvements on a smaller scale, Asian countries are pursuing large-scale investment plans to drive economic growth and enhance livability (Choi et al., 2020).

In this sense, as stakeholders' engagement has been emphasized as being crucial to produce morally balanced and socially aware smart city strategies as shown in the examples of New York, Barcelona and Amsterdam, it is noteworthy that it can provide valuable insights about the assets and needs of the city, increase public acceptance of smart city ventures and elevate urban smartness to a whole new level (Angelidou, 2014). As such, advanced smart city countries around the world are pursuing consistent policies such as developing creative services through active use of various data, securing space for free experimentation and testing of developed technologies and infrastructure, and adopting a public-private collaborative business structure, so it is expected that it will be able to solve issues of smart city projects that South

Korea is facing and at the same time provide proven factors to the smart city policy direction that the Korean government should pursue in the future (Jang, 2018).

2.2.2. Development of Smart City in Korea

In South Korea, significant strides in urban infrastructure were made through new city development initiatives in the 1990s. Subsequently, with the advent of the ICT industry and the internet in the 2000s, the development of U-City gained momentum, aiming to create a more efficient, safer, and transparent urban environment by digitalizing both citizens' lives and public infrastructure including the implementation of control centers equipped with sensors and CCTV (Lee & Han, 2019). Since 2008, the Korean government has been formulating comprehensive urban plans every five years and establishing U-Cities to address social issues across various domains such as urban expansion, housing, safety, environment, and energy, leveraging cutting-edge ICT technology for the integrated management of cities (Kim, 2020).

According to the Ubiquitous City Comprehensive Plan (Ministry of Land, Infrastructure and Transport, 2009), U-City is defined as a city that offers essential services anytime, anywhere, leveraging ubiquitous urban infrastructure constructed with ubiquitous urban technology to enhance urban competitiveness and residents' quality of life. However, despite the initial objectives, the promotion of U-City lacked a standardized model, leading to interoperability issues between cities and ambiguity regarding the project's scope (Kim, 2020). This resulted in several limitations, including discontinuity in public services, low citizen awareness, a technology-centric approach, and inadequate collaboration with stakeholders, nonetheless, it laid the groundwork for establishing cutting-edge infrastructure for smart cities and contributed to the proliferation of smart city initiatives (Hwang, 2010; Lee & Han, 2019).

To address the shortcomings of the U-City approach, which primarily emphasized predetermined infrastructure and services, the Korean government embarked on a path to foster innovation and tackle practical urban challenges by transforming the Act on Construction of Ubiquitous Cities, established in 2008, into the Smart Cities Act in 2017 (Choi et al., 2020). Under the Smart City Law, a smart city is defined as an urban environment where technology-driven infrastructure, diverse public services catering to citizen life, and social system development are closely intertwined to enhance the city's competitiveness and residents' quality of life compared to conventional cities (Ministry of Land, Infrastructure and Transport, 2017). Unlike the U-City model, which concentrated on constructing government-led information and communication infrastructure in new urban areas, smart cities are now

pivoting towards policies fostering more innovative services such as governance enhancement, data-driven urban policy formulation, and citizen-private sector collaboration, which encompasses aspects beyond infrastructure development, including data, spatial planning, and human resources (Jang, 2018; Lee & Han, 2019).

Table 2. Comparison Analysis of U-City and Smart City

Index	U-City	Smart City
Business Method	- When creating a new city, focus on providing infrastructure such as CCTV and communication networks - Focus on providing public services such as transportation, crime prevention, safety, and disaster prevention	- The goal is to solve practical urban problems based on data as well as basic infrastructure - Creating private services such as welfare in addition to providing public services such as traffic safety.
Promotion System	- Ministry of Land, Infrastructure and Transport and LH	- Open governance including all ministries, local governments, companies, and citizens
ICT	- Wired Internet network, broadband communication - Internet, 3G, RFID (Radio Frequency Identification)	- Wired and wireless communication network - ICBM (IoT, Cloud, Big Data, Mobile), AI
Information Delivery	- One-way transmission - Presence of time difference	- Two-way sharing - Real-time information
Citizen Role	- Information consumer (passive)	- Information producer and provider (leading)
Use of City Data	- Difficult to share city data due to operation by function within the city - Development of private solutions using data is not possible.	- A data sharing platform can be implemented through linkage between sectors within the city. - Private solutions can be developed (smart parking app, payment system)
City Management Implications	- Limitations in efficient distribution of urban resources due to information asymmetry - Government-led top-down approach to solving urban problems	- Efficient distribution of urban resources based on data (sharing platform, sharing economy) - Bottom-up approach involving the government, local governments, companies, and citizens

Source: 4th Revolutionary Committee. (2018)

By applying revised the Smart City Act in 2017, the Korean government is building various type of smart cities such as integrated platforms, theme-type specialized complexes, challenge projects and national pilot city projects tailored to each city's environment and characteristics through collaboration with local governments while in developed countries, smart cities are being built in a private-led manner (Kim, 2020). Kim (2020) classified different types of smart cities as follows: 1) integrated platforms type that aims to provide disaster relief, crime prevention, and support services for the socially disadvantaged by utilizing smart city technologies such as IoT and big data; 2) theme-type that specializes complexes type: aiming to improve the quality of life of residents, including transportation, energy, and crime prevention, and to enhance local industry and cultural competitiveness; 3) challenge projects

type that aims for a smart city that citizens can experience while reflecting the participation of private companies and the needs of local governments and citizens; and 4) national pilot city projects that aims to integrate new technologies and services related to 4th Industrial Revolution and create an innovative platform for city creation in which companies and citizens participate from the new city construction planning stage

Despite the progress made, smart cities in Korea still face limitations such as the absence of tangible services, the lack of successful models, and insufficient participation from the private sector. These shortcomings have led to criticism regarding their inability to achieve global competitiveness, a contrast to successful smart cities like Singapore, London, and Barcelona, which cities have established comprehensive promotion systems and consistent national strategies involving government entities, local administrations, corporations, and citizens (Jang, 2018; Jeong, 2021). Moreover, there is a pressing need to develop improved policies that facilitate collaborative governance for smart city development and these policies must take into account the intricate interplay between individual infrastructure, technological advancements, environmental considerations, and the driving forces led by both private entities and citizens (Lee & Han, 2019).

Hence, it is imperative to formulate policy alternatives and amendments to propel the development of sustainable smart cities. This involves identifying tangible services and successful models, as well as establishing an innovation platform that engages citizens, local governments, and companies. Subsequent chapters will delve deeper into these topics by analyzing both domestic and international smart city projects and associated policies.

2.3. Review of Smart Cities

The definition of smart city entails a city that remains true to the core objectives of a smart city, enhancing citizens' quality of life and evolving into a sustainable society through an innovative platform that prioritizes citizen participation and leverages advanced technology. Bakici et al. (2013) and Seong et al. (2016) underscore the critical role of creating a sustainable urban environment through the provision of tangible public services, leveraging advanced ICT technology to enhance citizens' quality of life. They identify key factors, including cutting-edge technology, national competitiveness, innovation platform, social interaction, collaborative relationships between the public and private sectors, citizen engagement, and policy support from local governments (Bakici et al., 2013; Seong et al., 2016).

2.3.1. Amsterdam

In a case of Amsterdam, the capital of the Netherlands, with a population of 118,000, the Amsterdam Smart City Programme, conceived in 2007 through collaboration between Amsterdam Innovation Motor, energy-network operator Liander, and the municipal administration, embodies the city's smart city strategy (Annen, 2011). Subsequently, the implementation of Amsterdam Smart City involves a partnership among businesses, authorities, research institutions, and the residents of Amsterdam, with over 70 partners, including CISCO and IBM (Angelidou, 2016).

Particularly, the smart city strategy of Amsterdam has been tactically aligned with priorities addressing climate change, aiming for substantial reductions in CO2 emissions (Mora & Bolici, 2017). This initiative includes goals such as a 20% reduction in greenhouse gases, a 20% expansion of renewable energy, and a 20% improvement in energy efficiency and the overarching vision is to achieve a 75% reduction in carbon dioxide emissions by 2040, aspiring to be the leading eco-friendly city in Europe (Manville et al., 2014). Additionally, the Amsterdam Smart City Programme fosters sustainable economic growth through technological innovation, leveraging ICTs, and encouraging citizens to adopt more sustainable lifestyles (Baron et al., 2012).

To attain these objectives, the Amsterdam Smart City Programme is shaped around the ongoing evolution of ICT-based projects, with each project undergoing testing and analysis in the initial pilot phase before being considered for continuous implementation on a larger scale (Angelidou, 2016). Throughout this process, the Amsterdam Smart City Programme adheres to important principles, including the constant stimulation and support of collaboration between the public and private sectors with the involvement of citizens, economic viability on a larger scale, and the significance of sharing and disseminating knowledge, which guide both the development of the strategy and individual projects (Mora & Bolici, 2017; Stahlavsky, 2011).

Table 3. ASC (Amsterdam Smart City) Platform's Major Smart City Projects

Project Name	Main Content	Performance
West Orange	Installation of energy meters, displays, and remote thermostats for 500 households.	· 14.4% reduction in energy usage · 13% reduction in carbon dioxide emissions
ITO Tower	Using smart building technology, install smart plugs to reduce energy and building maintenance costs and analyze the data.	· Reduce annual carbon dioxide emissions by 300 to 500 tons · 10-20% reduction in energy use · 5-10% reduction in building maintenance

		costs
Ship to Grid	Minimize the use of diesel engines by installing 73 land-based power plants to supply electricity generated to ships.	· 9.7% reduction in carbon dioxide emissions
Climate Street	Improving the environment of major shopping streets in Amsterdam and saving energy by distributing electric vehicles, smart meters, energy displays, and smart plugs.	· Replace 90% of garbage collection vehicles with electric vehicles · 80% of stores have smart meters installed
Geuzen-veld	Improving energy efficiency by distributing smart meters and smart displays to over 500 households.	· 8.9% reduction in carbon dioxide emissions · 7.4% reduction in electricity usage · 9.9% reduction in gas usage

Source: https://amsterdamsmartcity.com

To ensure substantial citizen involvement in the project development process, successful smart cities have adopted the living lab methodology, reflecting a commitment to an inclusive and participatory approach. The Amsterdam approach emphasizes the use of living labs for citizen involvement, aligning with strategic objectives and key principles, where technological solutions are determined through active engagement of citizens in real-life scenarios (Vermast, 2011; Baron et al., 2012). Additionally, Annen (2011) underscores the significance of uniting public and private entities and organizing activities that can ensure the effective implementation of the project as an open platform for their independent actions.

The advancement of individual projects necessitates early-stage selection based on criteria like feasibility, costs, and CO2 reduction potential, along with coordinated and implemented efforts involving suitable partners—a responsibility shouldered by the Amsterdam Smart City Foundation (Baron, 2012; Stahlavsky, 2011). Projects receive funding from various companies and government organizations involved in their execution, with the Amsterdam Smart City Foundation securing commitment and resources through signed collaboration agreements with partners (Mora & Bolici, 2017).

The Amsterdam Smart City model promotes transparency in project execution, collaboration, and evaluation, fostering open access to information for widespread knowledge sharing and the formation of new alliances within the public (Baron et al., 2012). Key information, including strategies, objectives, action priorities, strategic principles, financial strategies, stakeholders, and project results, is disseminated annually through over 50 domestic and international conferences, articles, and news, ensuring comprehensive communication (Amsterdam Smart City, 2013; Schuurman, 2011).

The success of Amsterdam Smart City can be attributed to the behind-the-scenes efforts of the local government and other partners, driven by strategic thinking, collaboration, and inclusive criteria (Mora & Bolici, 2017). More specifically, it is rooted in its adept integration

of ICT infrastructure and digital services, supported by committed leadership, inter-ministerial coordination, extensive stakeholder collaboration, a forward-looking vision, and projects that actively involve citizens in addressing local needs, steering clear of an overly top-down approach. (Komninos et al., 2014; Schaffers et al., 2011).

The ASC project goes beyond the basic plan, leveraging institutions and infrastructure to directly assist citizens and businesses in developing and experimenting with projects to achieve an eco-friendly city. In essence, ASC's approach is not solely centered on offering technical solutions but prioritizes fostering cooperation, co-creation, and partnerships among various stakeholders within the city of Amsterdam. In summary, Amsterdam Smart City is driving sustainable and eco-friendly urban development through a range of smart technology projects focused on improving energy efficiency and fostering collaborative relationships among the government, businesses, and citizens within the city, successfully advancing its implementation goals.

2.3.2. Barcelona

Barcelona, Spain's second most populous city with a population exceeding 1.62 million, has gained recognition for its pioneering initiatives in adopting and implementing information and communications technologies, dating back to the opening of its Municipal Computer Center in 1967 (Gasco-Hernandez et al., 2022). Since the 1980s, particularly following a near-collapse of its economy attributed to stagnation and high unemployment, Barcelona has sustained its prominence as a smart city (Kim, 2020). ICT has been pivotal in Barcelona's modernization processes, initially emphasizing the promotion of e-government and subsequently evolving to substantial investments in smart city initiatives (Gasco-Hernandez, 2018).

Barcelona Smart City integrates individuals, information, and other urban centers to establish a sustainable, eco-friendly urban environment, foster an innovative commercial landscape, and enhance the quality of life by ensuring the direct participation of citizens (Ajuntament de Barcelona, 2014). Despite similar objectives in other Western cities, the inadequate use of ICT technology often fails to meet local needs, and the exaggerated portrayal of its utopian benefits has limited impacts on social, environmental, and spatial development (Aurigi, 2006). This situation appears to stem from a lack of understanding that the integration of ICTs in urban areas is more crucial than technical considerations and placing excessive emphasis on infrastructure and device deployment can be misleading and potentially hazardous (Graham, 2000). The City of Barcelona has successfully developed its smart city strategy by

adopting an approach that appropriately combines the technological component with various "human factors," as emphasized by Nam and Pardo (2011), which has been essential to the initiative's success (Mora & Bolici, 2016).

The strategic approach in Barcelona involves sustained leadership and political commitment from the local government administration, irrespective of regime changes (Chourabi et al., 2012; Gasco-Hernandez et al., 2022). Emphasis has been placed on creating a collaborative and participatory environment to support smart city strategies (Manville et al., 2014), and the positive outcomes of Barcelona Smart City are attributed to the ongoing stimulation of public-private collaboration and citizen involvement mitigating the risks associated with an overly top-down perspective (Komninos et al., 2014; Mora & Bolici, 2016). Alongside leadership, political commitment, and collaboration, the Barcelona City Council adeptly manages critical elements including selectivity, vision, motivation, monitoring, and financial sustainability in its pursuit of smart city initiatives (Mora & Bolici, 2016). Tackling these significant challenges associated with smart city construction, Barcelona City Council employs a combination of public and private resources to ensure the sustainability of its smart city strategies (Noori et al., 2020).

Grounded in this pragmatic strategic approach, Barcelona Smart City interconnects individuals, information, and other cities, fostering a sustainable, eco-friendly urban setting, cultivating an innovative commercial environment, and enhancing the quality of life through direct citizen participation (Ajuntament de Barcelona, 2014). The city also fosters the generation of diverse ideas through an innovative living lab and open data environment, involving a cluster of companies, universities, and research institutes specializing in ICT ecology and urban planning within the service development process (Komninos et al., 2014). The core of the Barcelona Smart City model lies in its emphasis on smart governance, smart economy, smart life, and smart people, achieved through infrastructure, information, and human capital, fostering collaborative ties between citizens and businesses (Bakici et al., 2013).

Barcelona, in pursuit of its smart city goal, leverages technology to serve its people, emphasizing digitalization for an open, fair, circular, and democratic city; Barcelona Smart City foundation is dedicated to digital transformation, innovation, and citizen empowerment (Noori et al., 2020). Barcelona, with extensive experience in Living Lab initiatives, is developing a formal smart city strategy with a global perspective, aiming to create an open collaborative environment involving government, industry, academia, and citizens (Angelidou, 2016). The strategy comprises three pillars: international positioning, international cooperation,

and 22 smart local programs leading to over 200 projects covering areas such as public and social services, environment, mobility, enterprise, research and innovation, communication, infrastructure, tourism, and citizen cooperation (Gasco-Hernandez et al., 2022).

Table 4. Major Smart City Projects in Barcelona

Project Name	Main Content
Apps4Bcn Portal	Provides information necessary for city life such as arts, entertainment, sports, health, tourism, etc.
New Bus Network	Provides various traffic information for efficient movement within the city
Telecare Service	Emergency response services for the elderly, disabled, etc.
Open Data	Opening of information related to public administration, services, economy, population, region, etc.
Electric Vehicles	Reduces environmental pollution and improve energy efficiency through electric energy-based transportation
Barcelona Wi-Fi	Improving citizens' internet accessibility through Wi-Fi installation in 193 facilities and 276 streets
Smart Traffic Lights	Provides audio for the visually impaired and providing a passage for smooth emergency dispatch of fire trucks
School Route	Provides safe routes to and from school
ApparkB	Provides parking service using smartphones without using parking meters
Mobile ID	Provides a safe administrative process and administrative service use environment through electronic recognition through smartphones
Fabrication Laboratories	Provides learning programs on new scientific and technological models
OVAC	A system that provides services such as tax payment, information guidance, issuance of administrative documents, and filing of civil complaints.
mSchools	Provides secondary education programs using mobile technology
BCN Contactless	Provide information services related to the city by accessing signs with NFC and QR codes installed throughout the city through smartphones, tablets, etc.
Radars Project	Provides necessary help for the lives of the elderly through social networking with local residents, experts, volunteers, etc.
Sustainable Barcelona Map	Provides physical and social information about the city based on cooperative relationships between citizens
Bicing	Bike sharing system
Procedures Portal	Enhances government flexibility and accessibility by providing online city administrative services
Smart City Campus	As a dense area of companies, innovation centers and universities, it enhances synergies and co-creation efforts in new urban services and smart city models.
Smart Allotment	Program to promote collaborative thinking among students using new technologies
Smart Quesina	Bus information provision system using Wi-Fi and touch screen technology
Superblocks	Establishment of sustainable city strategy program through participation of the general public
Telemanaging Irrigation	Efficient water resource management system using smart devices
Vincles BCN	A digital platform to prevent social isolation among older people
City OS	A technological platform to improve citizens' lives and support urban management decision-making.
Barcelona Open Government	A government that pursues participation, transparency, and cooperation between the public sector and citizens
Sentilo	Open source code that is functional, open, interoperable, and extensible.
BUITS Plan	Urban regeneration project through temporary use of unused land
Citizen's Postbox	Smartphone application that provides accident information in real time

Barcelona Negocis	A council that discusses and diagnoses various city issues

Source: https://www.barcelona.cat

Illustrated in Table 4, the smart city initiatives underway in Barcelona not only deliver public services aimed at enhancing citizens' quality of life across diverse city domains but also ensure citizen involvement by collaborating with experts in the service development process to provide superior services. Barcelona Smart City, acknowledged as the fundamental underpinning of Barcelona's conceptual model, aspires to actualize a knowledge economy by establishing industrial networks and clusters rooted in the physical environment, including infrastructure and urban management systems developed through smart city construction (Kim, 2020). In this context, Barcelona Smart City represents the epitome of a city model that materializes a knowledge society, fostering ongoing interaction by establishing a space conducive to networks and communication among businesses, the public sector, and citizens (Bakici et al., 2013; Angelidou, 2016).

2.3.3. London

In 2012, London initiated its first concerted effort in smart city applications to manage public transport during the demanding conditions of the Olympic Games, leading to the establishment of the Smart London Board in 2013 (Park, 2020). In 2013, London released the Smart London Plan (SLP) in anticipation of population growth exacerbating congestion, air pollution, and strains on healthcare and utilities, emphasizing collaboration among citizens, businesses, researchers, investors, and stakeholders to provide inclusive solutions (Zvolska et al., 2020). The Smart London Plan, developed by the Board, is structured around seven core themes: prioritizing Londoners in innovation, fostering open data access, leveraging the city's research, technology, and creative talent, facilitating networking with smart city stakeholders, enhancing infrastructure development and management, improving City Hall services, and ensuring a smarter experience for all Londoners (Angelidou, 2016).

Regarding the open data policy which is one of the key success factors of smart cities, the Smart City Plan aims to provide all Londoners access to open data, fostering the development of London's research capabilities and creative talent through collaborations between the public and private sectors (Willems et al., 2017). The Smart London Plan underscores the necessity of collaboration among citizens, businesses, researchers, investors, and other stakeholders to provide inclusive solutions for all Londoners (Zvolska et al., 2020). The objectives outlined in this plan have been translated into various smart city initiatives and

put into action. The London Office of Technology and Innovation serves as a collaborative platform for various localities within Greater London to enhance digital innovation in public services, engaging technology startups to develop applications and solutions aimed at addressing the city's most pressing urban challenges (Shamsuzzoha et al., 2021).

The city of London aims to leverage its resources, including a skilled workforce, a thriving tech startup community, and top-tier universities, to implement projects that foster innovation and drive economic growth (Kadiri et al., 2023). Integration using networks related to technological innovation is institutionalizing the Smart London Innovation Network, which provides opportunities for smart city-related organizations to collaborate and grow (Park, 2020). While London's smart city strategy primarily centers on institutional and digital domains, the digital quarter known as 'Here East' represents a convergence of London's technological advancement, business, and technology and media sectors, facilitating innovative technologies that underpin the smart city, serving as a campus, it fosters a local ecosystem of education and innovation driven by data (Angelidou, 2016).

Regarding citizen participation, a crucial element for the success of a smart city, the Smart London Plan has endeavored to engage stakeholders while addressing citizens' needs through innovative approaches to various social aspects like health, education, and training (Park, 2020). Indeed, the majority of smart city projects prioritize citizen participation, aiming to engage citizens consciously and actively, thereby emphasizing their role in policy decisions in a more democratic manner (Willems et al., 2017). In response to regulations conflicting with innovative business activities in London, the local government analyzes the impact of company innovations on existing businesses to accentuate positive aspects and mitigate negative ones, implementing deregulation policies to foster the development of innovative smart cities (Zvolska et al., 2020).

Table 5. Major Smart City Projects in London

Project Name	Main Content
Barclays Cycle Hire	Citizens can access information on where they can use city bikes, availability and use of bikes.
Care connect (NHS)	A Customer Relationship Management system to ensure effective management and tracking of requests, supported by a moderation and case handling service.
Free WIFI in public spaces	Free WIFI in public spaces
Legible London	Integrated way finding system helping people move around the capital with over 1250 signs now installed
Listen London Platform	Listen London is a bespoke tool used to listen to social media talk about London related issues.

London Datastore	Public availability of various datasets on London
London's Dashboard	A public reporting tool on how city is performing and what City Hall and London boroughs are doing about it
Love Clean London	Use of apps and mobile phones to report quality issues in cleanness of London streets and parks
Smart grid technologies	Virtualize city infrastructure to better manage supply and demand (e.g. water, energy, road infrastructure, underground assets) across London
Smart London Innovation Challenge	Series of initiatives to mobilize entrepreneurs, researchers, businesses and citizens to develop solutions
Smart London innovation Network	A network to link London's entrepreneurs and innovators with the organizations already delivering and financing London's new infrastructure and services.
Smart London Platform for feedback	An online platform to enable Londoners to feedback, rate and shape the type of experience they want to have
Talk London	An online research community between Londoners and City hall including polls, discussions, live Q&A, surveys, and focus groups
Tech City Institute	Centre and meeting space for citizens to discuss and learn how new technologies impact different parts of society
Transport for London - Innovation Portal	An online tool that encourages users to submit innovative technological ideas to help address London's core transport challenges

Source: Willems et al. (2017)

As evident from the diverse projects outlined in Table 5 above, London is recognized as a successful smart city, underscored by its technological innovation, transparent public data, advocacy by the Smart London Board, collaborative efforts between public and private sectors, citizen-centric platforms, and proactive regulatory innovation by local governments. Indeed, the success of London's smart city initiatives can be attributed to various factors, notably the prioritization of citizen participation as a critical success factor and the availability of ample publicly accessible information on a range of smart city projects (Willems et al., 2017).

2.3.4. New York

The goal of a smart city is to optimize and sustainably manage resources to enhance citizens' quality of life, while balancing social, environmental, and economic considerations amidst urban population growth. Smart cities have emerged as a burgeoning market, projected to reach around $3 trillion by 2020, with the perceived value stemming from enhanced operational efficiencies within urban environments and the emergence of new enterprises (Anthopoulos, 2017). New York City, home to approximately 8.3 million people, holds the distinction of being the most populous city in the United States and it garnered recognition as the Best Smart City in 2016 at the Smart City Expo World Congress, showcasing its advanced initiatives in the realm of smart city development. (Shah et al., 2019). In New York's case, initiatives like OneNYC in 2015 aimed to cultivate a city grounded in advanced manufacturing, incorporating measures to support the growth of traditional industries through key elements

such as talent development, infrastructure enhancements, and network construction (Jeong et al., 2020).

New York's Smart City initiative emphasizes sustainability, smarter land use, and citizen engagement through digitalization, supported by the Department of Information Technology's commitment to providing extensive information resources (Pearsall, 2013). Orum (2019) contends that New York City's smart city initiatives primarily prioritize areas such as transportation management, water and power grid optimization, implementation of smart neighborhood tools, and the deployment of electric vehicle charging stations. As seen in the execution and performance of projects like Smart Waste Management, Smart Water Metering, and the Better Buses Action Plan, as depicted in Table 6, involving sensor technologies that monitor air and water quality, as well as traffic control through leveraging both public and private open data sources (Shah et al., 2019), New York's Smart City initiative demonstrates a strong commitment to environmental sustainability by integrating sustainable green policies aimed at reducing air and water pollution and promoting the use of renewable energy sources (Razmjoo et al., 2022).

Table 6. Major Smart City Projects in New York

Project Name	Main Content
Smart Waste Management	Big Bellys are smart trash cans being installed across the city. It is useful for planning an efficient pick-up trip by using a wireless sensor that monitors trash levels, and the compactor using solar power allows for 500% improved waste holding.
Smart Water Metering	AMR (Automated Meter Reading) monitors and reports water usage. It also collects data about rain-water harvesting and grey-water recycling levels.
LinkNYC	New York City offers fast and free public Wi-Fi, along with access to government information and 311 apps for various services, funded through advertising revenue.
NYC Open Data	It is provided in a variety of ways so that universities or private organizations with specialized technology can analyze the collected data through NYC 311 and use it efficiently for various projects or to improve the lives of citizens.
Smart Park	The installation of multi-purpose benches allows citizens to utilize parks more effectively, offering amenities like free mobile charging. Additionally, the government can gather information from the benches to determine park planning and budget needs.
Better Buses Action Plan	Utilizing Transit Signal Priority (TSP) technology, traffic signals stay green as a bus approaches, granting priority to the bus and resulting in a bus speed improvement of over 25%.
Brownsville Innovation Lab	One initiative is the launch of a neighborhood innovation lab in Brownsville, Brooklyn, one of the most problematic zones in the borough. Project managers provided residents with access to healthy food, public safety at night, and better waste management solutions.
New York Citi Bike	A bike-sharing system operative in Manhattan, Northern Brooklyn, and Western Queens. The program deploys hundreds of stations with bikes that are available 24/7. Citi Bike's connected app helps users find the closest available bike in real-time and tells app users how to get to a station.

HunchLab	HunchLab is a software solution that uses historical data and terrain modeling to predict crime occurrence. This solution can identify crime hotspots, helping police increase public safety in this area. The two-year trial successfully and significantly lowered violent crime in New York.
Smart Street Lighting	NYC launched the Accelerated Conservation and Efficiency (ACE) program in 2013. The city aims to upgrade city lights with LED retrofits, thus saving energy usage. The program features smart technology, which controls the intensity of the light, and schedules the hours of operation according to the number of occupants in the vicinity at the moment.
Futureworks NYC	It provides financial support of $30,000 over two years to early-stage startups related to high-tech manufacturing, and separately operates programs such as maker spacers, incubators, and workshops.
NYC Mesh	It is a non-profit project to form a regional public Wi-Fi network through the voluntary participation of citizens. All necessary personnel, from router installation to network management, are comprised of volunteers, and operating costs are covered through donations.
NYC GISMO	This is a forum for sharing news about data and data processing technologies, software training, GIS publications, conferences, and vendors. It operates based on member volunteerism and builds New York's largest geographic information system through cooperation between the government, experts, and the private sector.

Source: Shah et al. (2019); https://www.nyc.gov; Kim. (2018)

While New York City has long been a global economic hub, its focus on smart city projects is primarily aimed at fostering local growth rather than enhancing international competitiveness and this approach aligns with its commitment to open data policies, which prioritize local development and community empowerment (Anthopoulos, 2017). New York City's data-driven approach to smart city initiatives, illustrated by the analysis of illegal remodeling reports through NYC 311, demonstrates the efficient use of data and citizen participation to address urban challenges (Kim, 2018). These instances serve to encourage greater citizen participation by signaling to residents that their active reporting can contribute to the improvement of the city. New York City prioritizes citizen-centered approaches, leveraging open data and encouraging citizen participation to enhance resource utilization and improve citizen experiences in these fields such as waste and water management, air quality control, urban lightning, park improvements, and the provision of public Wi-Fi as smart solutions (Shah et al., 2019).

New York City is evaluated as the most successful smart city because smart infrastructure and services support its transformation to livable ones such as job creation and local economic recovery in terms of local quality of life and citizen satisfaction through open innovation platforms and open data (Anthopoulos, 2017).

The characteristics of Amsterdam, Barcelona, London, and New York smart cities examined so far are summarized as follows.

Table 7. Comparative Analysis of Characteristics of Smart City Cases

	Amsterdam	Barcelona	London	New York
Goal	Building Europe's most eco-friendly city based on innovative technologies and civic participation	Making the city more livable, sustainable, and innovative through the use of technology and data	Building cities that improve quality of life, connectivity and sustainability through open data, transparency, technology, collaboration and citizen engagement.	Making the city that creates accessible spaces, facilitates collaboration, and establishes connections through open data and citizen engagement.
Participants	Citizens Businesses Local government Research institutes	Citizens Businesses Universities Research institutes Politicians Local government	Citizens Businesses Researchers Investors Local government	Citizens Businesses Universities Researchers Local government
Main Projects	West Orange ITO Tower Ship to Grid Climate Street Geuzen-veld	New Bus Network Open Data Barcelona Wi-Fi OVAC City OS	London Datastore Listen London Love Clean London Talk London Tech City Institute	LinkNYC Smart Waste Management Smart Water Metering Smart Park
Characteristics	Political commitment ICT-based projects Citizen involvement Collaboration in public and private Transparency Living labs	Leadership Political commitment Citizen participation Collaboration in public and private Transparency Living labs	City governance (Talk London) Citizen participation Digital inclusion Open innovation among stakeholders in a bottom-up way	Citizen participation Digital inclusion Data-centered Open innovation Collaboration in public and private Living labs

Source: https://amsterdamsmartcity.com, https://www.barcelona.cat, Willems et al. (2017), Shah et al. (2019)

Upon closer examination of Table 7, the conspicuous absence of key factors that contrast with the attributes of a successful smart city becomes evident. Those factors encompass the absence of robust data governance, the implementation of innovative technologies and projects detached from practical application, inadequate sustainable strategies, low levels of citizen participation, deficient collaboration between public and private sectors, and unclear roles of local governments. This study juxtaposes the attributes of successful smart city cases with those of smart cities that failed or necessitate enhancement, offering insights into the necessary policy supplementation and factors requiring reinforcement for the growth of sustainable smart cities.

2.3.5. Toronto

In 2017, amid growing interest in smart cities and urban competition, Sidewalk Labs, a subsidiary of Google, collaborated with the public corporation Waterfront Toronto to propose

a smart city in Toronto's Quayside, intending to tackle urban challenges and shape the future (Artyushina, 2023). The announcement of Google's involvement in the project to design Toronto's Quayside garnered widespread public attention and controversy for the scope and ambition of its proposals (Haggart & Spicer, 2022). However, the largest smart city project in North America, based in Toronto, Canada, was ultimately abandoned due to issues including the COVID-19 pandemic, strong opposition from residents and civic groups, the undisclosed details regarding stakeholders' financial commitments and privacy concerns (Goodman & Powles, 2019). This project serves as an evaluative example that distinctly showcases the potentials and limitations of smart cities. This study aims to explore the nature of Google's smart city project, analyze the reasons for its failure, and derive valuable lessons from the experience.

In October 2017, Sidewalk Labs entered into a partnership with Waterfront Toronto to develop an 8.1 million square meter smart city in the lakeside district of Ontario, Canada (McCord & Becker, 2019). The Sidewalk Labs business proposal outlines the establishment of a system to identify and manage road congestion using sensors, the introduction of autonomous driving technology, and the promotion of eco-friendly urban design with goals such as reducing pollution, traffic congestion, and landfill waste (Sidewalk Labs, 2019). The proposal includes initiatives like autonomous shuttle transportation, a human movement detection transportation system, collection of environmental data through a high-performance communication network, heated bicycle passages, and robotic cargo transportation through underground city tunnels (Tierney, 2019).

The Google Toronto Smart City project encountered numerous challenges leading to its failure, including resident opposition, privacy concerns, lack of collaboration with diverse stakeholders, and the inability to establish effective control and governance with both federal and local governments. Morgan and Webb (2020) contend that despite increasing efforts to prioritize citizens, there is still a crucial requirement for advocates who can safeguard and advance the broader public interest, acting as a mediator to address the tensions between technology-centric and citizen-centric aspects within the evolving landscape of smart cities. Wylie (2018) emphasizes that currently, residents lack the opportunity to express their opinions on the smart city through public consultation, as key questions remain unanswered and the issues have not been adequately explained or communicated. This highlights the arbitrary and closed nature of their smart city plan, demonstrating that it prioritized technology-oriented private interests without taking citizen participation into account from the outset of the project.

Interestingly, Sidewalk Labs operated in secrecy while advancing corporate ideals of smart urbanism, growing distant from public interests, consequently, the conflict between the business sector and civil society has eroded the momentum of citizens and other stakeholders for collaboration as the primary actors in the Toronto Smart City initiative (Flynn & Valverde, 2019). Furthermore, due to Sidewalk Labs' preoccupation with its own interests, the engagement of city planners, diverse technology firms, and citizens in the Toronto Smart City project was restricted, prompting several companies to withdraw from collaboration, ultimately resulting in a decline in the project's covert agenda and fostering citizen opposition (Morgan & Webb, 2020).

The concern among Torontonians about Google potentially gaining significant control over the city, thereby compromising its autonomy and residents' rights, has escalated amid revelations that the smart city project has expanded beyond the scope initially outlined in the contract, leading to heightened tensions between the city council and the waterfront (Flynn & Valverde, 2019). Finally, Toronto citizens raised questions and concerns regarding the scope, utilization, and safeguarding of data collected by Google, prompting the Canadian Civil Liberties Association (CCLA) to file a lawsuit against the government in April 2019, seeking the nullification and immediate suspension of the Toronto Smart City contract (Morgan & Webb, 2020). Flynn and Valverde (2019) highlighted that the data privacy concerns in Toronto's Smart City initiative, which sparked significant protests and legal challenges from civic groups, stemmed from Waterfront Toronto's failure to establish a robust policy framework for data privacy and its lack of authority to address data-related issues. It has even been pointed out that Waterfront Toronto does not possess the capacity to implement or evaluate data-intensive infrastructure, as a result, it was unable to articulate what citizens wanted and needed from a data-intensive infrastructure (Haggart & Spicer, 2022).

Vincent (2018) argues that the smart city agreement between Waterfront Toronto and Sidewalk Labs lacked crucial local government legal and governance frameworks, despite showcasing impressive concepts such as waste removal and recycling from buildings through underground tubes without the benefit for trucks on streets. Bliss (2018) highlights the absence of a formal agreement between the two organizations, leading to the creation of Sidewalk Toronto, an unconventional quasi-official entity, raising questions about the extent of collaboration between Waterfront Toronto and Sidewalk Labs on smart city initiatives. This recklessness is also evident in the undisclosed agreement between Waterfront Toronto, lacking proper land rights, and Sidewalk Labs, primarily driven by private corporate interests (Flynn

& Valverde, 2019). Notably, credible reports suggest that Sidewalk Labs, not Waterfront Toronto, is granting itself intellectual property rights, including an exclusive royalty-free global license, to utilize any innovations (Goodman & Powles, 2019). The two organizations became overly fixated on a superficial partnership, driven by the technological allure of a smart city, while neglecting the essential groundwork for substantive collaboration and the establishment of a robust financial and legal governance framework.

In the development of smart cities, pioneering companies like Sidewalk Labs should aim not only to accumulate more data or financial gains but also to actively engage in sharing the authority to plan public spaces (Flynn & Valverde, 2019). This case holds broader implications for smart cities beyond Toronto and Canada on ensuring transparency, accountability, and civic engagement in direct planning collaborations with private entities.

2.4. Smart City Initiatives that Necessitate Enhancement

In the previous chapter, this study examined successful and failed smart city cases in various developed countries overseas. On the other hand, U-City, Songdo, and Sejong smart cities in South Korea, which had been promoted as national projects, experienced sluggish support unlike the initial initiatives. Despite building smart infrastructures based on cutting-edge ICT technology within a short time, crucial polices for sustainable smart cities, such as citizen participation, business involvement, public-private collaboration, and the revitalization of living labs, which are ultimately pursued in smart cities, were not adequately implemented. In this study, U-City, Songdo Smart City, and Sejong Smart City were chosen as examples of such smart cities to investigate contributing factors to rejuvenating smart city initiatives from a policy perspective.

2.4.1. U-City

In the 2000s, spurred by the growth of the ICT industry and the internet, the development of U-City gained momentum, striving for a digitally enhanced city with increased efficiency, safety, and transparency by integrating sensors and CCTV into citizens' lives and public infrastructure, including control centers (Lee & Han, 2019). Since 2008, the Korean government has been formulating a comprehensive urban plan every five years, introducing U-City to address diverse societal issues like urban expansion, housing, safety, environment, and energy and this approach leverages advanced ICT technology for the integrated management

of the city (Kim, 2020). The Ubiquitous City Comprehensive Plan (Ministry of Land, Infrastructure and Transport, 2009) defines U-City as a city that offers essential services anytime, anywhere, utilizing ubiquitous urban infrastructure and technology, aiming to enhance urban competitiveness and residents' quality of life. Due to the implementation of legislation, cutting-edge technology, and widespread government support, LH's nationwide new city projects promoting U-City, at the time, generated high expectations, heightening the public desire for a highly developed future city.

However, the rapid promotion of U-City revealed its limitations as a technology-centered, piecemeal approach with a public-led, top-down propulsion system (Baek, 2017). In contrast to the initially set goal, U-City was promoted without a standardized model, leading to confusion in interoperability issues between cities and setting the scope of the project (Kim, 2020). Hwang (2010) argues that the failure of U-City can be attributed to its inability to provide continuous public services after the initial installation of necessary ICT infrastructure, exposing limitations in raising citizens' awareness. Lee & Han (2019) observed that U-City was predominantly centered on a technology-focused approach, emphasizing uniform and simplistic ICT infrastructure, leading to a lack of strategic partnerships with diverse stakeholders for sustainable urban management and development. In contrast to the smart city policy, which aims for a city centered on citizen participation, advanced technology, and a sustainable environment to enhance the quality of life, U-City ultimately focused solely on constructing public-led information and communication-related infrastructure in new urban areas (Jang, 2018).

Table 8. Comparative Analysis of U-City and Smart City

Index	U-City	Smart City
Business Method	- When creating a new city, focus on providing infrastructure such as CCTV and communication networks - Focus on providing public services such as transportation, crime prevention, safety, and disaster prevention	- The goal is to solve practical urban problems based on data as well as basic infrastructure - Creating private services such as welfare in addition to providing public services such as traffic safety.
Promotion System	- Ministry of Land, Infrastructure and Transport and LH	- Open governance including all ministries, local governments, companies, citizens
ICT	- Wired Internet network, broadband communication - Internet, 3G, RFID (Radio Frequency Identification)	- Wired and wireless communication network - ICBM (IoT, Cloud, Big Data, Mobile), AI
Information Delivery	- One-way transmission - Presence of time difference	- Two-way sharing - Real-time information
Citizen Role	- Information consumer (passive)	- Information producer & provider (leading)

Use of City Data	- Difficult to share city data due to operation by function within the city - Development of private solutions using data is not possible.	- A data sharing platform can be implemented through linkage between sectors within the city. - Private solutions can be developed (smart parking app, payment system)
City Management Implications	- Limitations in efficient distribution of urban resources due to information asymmetry - Government-led top-down approach to solving urban problems	- Efficient distribution of urban resources based on data (sharing platform, sharing economy) - Bottom-up approach involving the government, local governments, companies, and citizens

Source: 4th Revolutionary Committee. (2018)

Moreover, in terms of collaboration with stakeholders, including citizens, who are considered a key element in urban development, Anttiroiko (2013) criticized Korea's U-City for its unbalanced collaboration, asserting that the public bore major risks while private construction and ubi-tech companies reaped economic benefits, leaving citizens as passive inhabitants in the technologically mediated city. Regarding cooperative governance between central and local governments, Yigitcanlar and Lee (2014) argued that in the U-City project, although the local government was a major stakeholder in the project, national development took priority over local development, and as a result, local needs were not properly reflected. Rotondo (2012) argues that U-City projects ought to drive changes in urban planning participation processes, presenting an opportunity to establish genuine e-democracy, however, current practices in the Korean context, aside from a few limited user-generated content applications, do not adequately facilitate avenues for e-democracy.

The crucial question at hand is whether these cities can genuinely enhance the quality of life and sense of place by predominantly emphasizing the built environment while largely neglecting the natural environment (Yigitcanlar & Lee, 2014). In essence, unlike the initial initiative, it exhibited negligence in fostering a sustainable environment, leading to an evaluation of failure in achieving urban development that encompasses economic, social, and environmental balance.

2.4.2. Songdo

Songdo city is strategically designed and constructed as a prominent international business district situated within the Incheon Free Economic Zone (IFEZ) in South Korea. The city aims to evolve into a key business and research hub, emphasizing the creation of an environmentally sustainable community through extensive utilization of advanced information and communication technologies (IFEZ, 2010). In Songdo smart city, Cisco demonstrates its

Smart + Connected Communities program comprehensively by implementing a network that interconnects all facets of the city, encompassing residences, offices, and schools allowing residents to remotely control various functions in their homes, and facilitates seamless interaction for everyone through Cisco's telepresence system (CISCO, 2013).

Table 9. Major Smart City Services in Songdo Smart City

Main Services	Service Contents
Transportation	- A service that improves transportation convenience by providing various traffic information in real time - Intelligent traffic flow management, emergency situation management, bus arrival information, and parking guidance service - The bus information terminal provides bus arrival information in multiple languages, including Korean and English. - Monitoring bus stops through CCTV, taking action in case of emergency - Real-time monitoring of traffic flow information and unexpected situations using cameras and detectors
Environment	- Services providing air quality information, water quality information, environmental information, etc. - Real-time detection of fine dust, visibility, road surface icing, etc. with state -of-the-art detection sensors
Safety	- A service that acquires, monitors, and analyzes information on city security, crime prevention, incidents, and accidents in real time. - CCTVs installed throughout the city utilize intelligent video surveillance to detect and respond to abnormal situations such as wandering. - CCTVs installed at major intersections recognize wanted vehicles and take action accordingly.
Disaster	- A service that prevents disasters by monitoring major areas within the city And creates a safe city life through a rapid response system linked to the police and fire departments. - In the event of a disaster, citizens are advised to evacuate through the web, electronic signs, speakers, etc.
Facility	- Monitors the status of on-site installed facilities (traffic cameras, atmospheric information sensors, crime prevention CCTV, etc.) to provide a basis for quick action in the event of a failure. - The smart city operation center comprehensively manages various facilities based on information collected through RFID, sensors, etc.

Source: Son (2018); https://www.ifez.go.kr

Songdo exemplifies how the smart city employs technological systems to redefine citizens as valuable subjects, prepared to compete in the global knowledge economy, thereby underscoring the exclusionary facets inherent in the concept of a smart city (Benedikt, 2016).

Since the inauguration of the initial phase in 2009, Songdo Smart City's development has faced sluggish progress, deviating from the original plan due to challenges such as budget constraints, inadequate government support, bureaucratic hurdles, regulatory issues, resistance from stakeholders, and difficulties in attracting foreign capital investment (Shwayri, 2013). Indeed, the government's inconsistent policy changes, such as the strengthening of regulations, have adversely affected the development of Songdo Smart City related to corporate investments.

In 2009, investors expressed concerns that the government's revised policy regulating condominium sales could significantly dampen buyer interest in the top 30 floors of the Northeast Asia Trade Tower (NEATT), slated to become South Korea's tallest building (Kshetri et al., 2014).

Songdo, touted as the city with the fastest-growing wealth ratio in South Korea, has fallen short of its fundamental goal of providing affordability for citizens to work and live, primarily due to the elevated apartment prices in smart cities (Caprotti, 2014). Mega-projects like the New Songdo City, tailored for wealthy businesspeople who prioritize convenience, seem to enjoy broad legitimacy in the country and South Korea has arguably overlooked the wider welfare and social support requirements of older individuals (Kshetri et al., 2014). Regarding inclusiveness and openness for more active participation of citizens in smart cities, the requirement for an official resident's key to use a street waste bin, preventing non-residents from accessing this service, highlights a lack of openness in the development of smart city services centered on citizen participation, serving as a critical issue and a noted limitation of Songdo Smart City (Mullins, 2017).

The challenges faced by Songdo Smart City, including budget constraints, insufficient government support, bureaucratic hurdles, regulatory issues, stakeholder resistance, and difficulties in attracting foreign capital investment, have substantial implications for its sustainable growth and represent critical tasks that must be addressed for the continued development of the smart city.

2.4.3. Sejong

Sejong City has been designated as a versatile administrative capital, recently developed for multifunctional purposes. Sejong City, chosen as a national pilot city development project, is evolving into a smart city with a focus on energy and transportation, aiming for self-sufficiency by integrating functions like housing, administration, research, and industry around the nearby Government Complex and national research complex (Na et al., 2020). Sejong Smart City, supported by government budget, integrates cutting-edge technology to develop citizen-experienced services within the pilot city, connecting various ministry projects and technology developments to implement smart infrastructure and services across transportation, energy, safety, healthcare, and more (Bae, 2019).

In terms of governance, Sejong Smart City aims to foster citizen participation by systematizing platforms like living labs, so this enables citizens to propose opinions on local

issues and directly address them in areas such as education/jobs, energy/environment, safety/life, and culture/shopping, ultimately enhancing the quality of life for residents (Ministry of Land, Infrastructure and Transport, 2019).

Table 10. Major Innovation Components and Projects in Sejong Smart City

Innovation Components	Main Projects
Mobility	Personal mobility/car sharing service, autonomous driving, integrated mobility, smart parking
Education/Jobs	Smart learning space (online, offline) edutech, introduction of learning system (IB), lifelong education service
Energy/Environment	Urban crime prevention service, smart living convenience service, fine dust reduction system
Safety/Life	Opening of information related to public administration, services, economy, population, region, etc.
Culture/Shopping	Performer-audience customized linkage service, construction of variable performance culture space, smart integrated delivery service
Governance	Providing a citizen-participatory decision-making system
Healthcare	Personalized health management service, AI-based emergency medical system, smart home doctor service

Source: https://www.sejong.go.kr

Despite Sejong City's multifaceted policy initiatives to establish a sustainable smart city, concerns have been raised regarding the low perception among citizens of various services and their limited participation and engagement in platforms like living labs for service development. Cho and Oh (2019) underscore the policy imperative to rejuvenate a smart research park akin to Makerversity in Amsterdam, DOLL Institute in Copenhagen, and Science Park in Singapore which facilitate innovative planning, experimentation, and city operation involving citizens, companies, and stakeholders, fostering collaborative idea-sharing based on open data.

Sejong Smart City, from its inception, has grappled with political influence, leadership challenges, and restricted involvement from private stakeholders, including citizens (Lim et al., 2023). With the change in regime around 2010, the Ministry of Land, Infrastructure, and Transport (MoLIT) designated Sejong City successively as a U-City test bed, a zero-energy smart city in 2016, and a national pilot city for k-Smart City in 2018, demonstrating a significant exertion of political influence on Sejong City (Leem et al., 2019). The National Agency for Administrative City Construction (NAACC), established in 2006 as a public agency, independently oversaw the construction and administration of Sejong until the municipality's official initiation in 2012, after which it became a department of MoLIT, leading to conflicts with Sejong municipality over project leadership (Lim et al., 2023)

Additionally, concerning civic participation for innovation, a crucial aspect in smart cities, it has been noted that innovation activities within the private sector including citizens

are relatively limited contrary to citizens' expectations (Yang & Lee, 2023). Indeed, public agencies played a substantial role in decision-making, with other actors having, at best, a participant role, while citizens were limited to participating in public contests or events organized by public agencies and the private sector's involvement in the project is primarily in an executor role under LH's supervision through contractual arrangements (Lim et al., 2023).

The characteristics and limitations of Toronto, U-City, Songdo, and Sejong smart cities examined so far are summarized as follows.

Table 11. Comparative Analysis of Smart City Initiatives that Necessitate Enhancement

	Toronto	U-City	Songdo	Sejong
Goal	A city that solves urban problems and leads the future based on data and advanced ICT	A city that provides access to public services through any connected device to enhance urban competitiveness and residents' quality of life	The city aims to become a leading business and research hub, focusing on environmental sustainability through advanced ICT utilization	A city that is evolving into a smart city centered on energy and transportation, integrating functions like housing, administration, research, and industry
Participants	Sidewalk Labs Waterfront Toronto Businesses	Government Businesses Public corporation (LH)	Government Businesses (CISCO) Developers Public corporation (LH)	Government Businesses Public corporation (LH)
Main Projects	City management through analysis of big data and AI Self-driving cars and real-time traffic information Establishment of a renewable, eco-friendly energy system Revitalizing public space and building a digital platform	Infrastructure such as CCTV & networks City management using public city data Public services such as transportation, crime prevention, safety, disaster prevention	Intelligent traffic flow management Real-time detection of fine dust A service that prevents disasters by monitoring major areas CCTV for urban safety	Autonomous driving Smart learning space Urban crime prevention service Fine dust reduction Opening of public information A citizen participatory decision-making
Drawbacks	No framework for data governance Lack of civic engagement Lack of local government's role No collaboration among stakeholders Lack of public openness for citizens	Excessive focus on technology Top-down urban development Citizens as passive consumers Lack of interoperability between cities Absence of collaboration among stakeholders	Budget constraints Insufficient central government support Bureaucratic hurdles Regulatory issues Stakeholder resistance Difficulties in attracting foreign capital investment Lack of inclusiveness, openness for citizens	The low perception among citizens of various services Lack of citizen engagement in living labs Political influence Leadership issue between central government and local government Restricted involvement of private stakeholders

Source: Sidewalk Labs. (2019); 4th Revolutionary Committee. (2018); https://www.ifez.go.kr; https://www.sejong.go.kr

Upon closer examination of Table 11, the conspicuous absence of key factors that contrast with the attributes of a successful smart city becomes evident. Those factors encompass the absence of robust data governance, the implementation of innovative technologies and projects detached from practical application, inadequate sustainable strategies, low levels of citizen participation, deficient collaboration between public and private sectors, and unclear roles of local governments. This study juxtaposes the attributes of successful smart city cases with those of smart cities that failed or necessitate enhancement, offering insights into the necessary policy supplementation and factors requiring reinforcement for the growth of sustainable smart cities.

III. Methodology

3.1. Data Collection

For this study, in-depth interviews were conducted with a total of 14 participants, including an expert group (researchers and practitioners) and a citizen group. The 14 interview participants included three researchers engaged in smart city policy research and implementation, two practitioners responsible for Sejong Smart City planning and design, and nine citizens residing in smart cities such as Seoul, Sejong, Songdo, and Busan. The researchers from the public institution plays a pivotal role in promoting the development of smart cities were selected due to their extensive involvement in planning national-level smart city policies with the Ministry of Land, Infrastructure and Transport for 5-7 years, as well as their roles in reviewing actual smart city plans at both national and local government levels. They also serve as coordinators for living labs in smart cities, making them among the few researchers in Korea recognized for their expertise in both theoretical knowledge and practical implementation of smart city policies. The practitioners from the public institution dedicated to researching smart cities were chosen for interviews because they are actively engaged in smart city-related projects with the local government, particularly the Sejong City Administrative Complex Office, aligning with national smart city policies. With at least 5 years of direct involvement in designing and implementing Sejong Smart City, they possess an unparalleled understanding of the smart city landscape and the role of local governments.

Furthermore, the nine citizen interviewees were selected from diverse regions, including Sejong City, Busan City, Seoul City, and Songdo City. These areas were chosen because they

represent different approaches to smart city development in South Korea, ranging from national pilot projects to local government initiatives, encompassing both men and women aged between their 20s and 50s. This research delves into citizens' perceptions regarding smart cities, their understanding of the factors influencing development and future prospects, and the role of local governments, aiming to compare their perspectives with those of researchers and practitioners. This study aims to analyze the factors perceived by citizens as having a positive influence on smart city awareness, development, the role of local governments, and the future outlook for smart cities. It also seeks to explore differences in perspectives and perceptions between researchers and practitioners involved in smart city initiatives as well as citizens residing in smart cities.

Table 12. Summary of Characteristics/Demographics of Participants

Respondent	Gender	Age Group	Education Level	Job	Career Year	Residence	Period of Residence
Researcher A	Male	50s	Doctoral	researcher	20	-	-
Researcher B	Male	50s	Doctoral	researcher	20	-	-
Researcher C	Male	40s	Doctoral	researcher	9	-	-
Practitioner A	Male	40s	Bachelor	worker	17	-	-
Practitioner B	Male	40s	Bachelor	worker	17	-	-
Citizen A	Male	50s	Master	Employee	-	Seoul	32
Citizen B	Female	40s	Master	Self-employed	-	Seoul	38
Citizen C	Male	30s	Bachelor	Employee	-	Sejong	4
Citizen D	Female	40s	Bachelor	Employee	-	Sejong	5
Citizen E	Male	30s	Bachelor	Employee	-	Songdo	8
Citizen F	Female	40s	Bachelor	Employee	-	Songdo	8
Citizen G	Male	40s	Master	Employee	-	Busan	5
Citizen H	Male	20s	Bachelor	Employee	-	Busan	29
Citizen I	Female	30s	Bachelor	Employee	-	Busan	34

3.2. Data Analysis

The in-depth interview questions for smart city data analysis are divided into four studies. Each study addresses different aspects related to smart cities and aims to gather insights from participants. Study 1 of the in-depth interview questions focuses on factors influencing citizens' awareness of smart cities. It includes inquiries about the significance of smart city creation, the effectiveness of promotional strategies, preferences for development areas, and factors impacting quality of life. Study 2 comprises two questions focused on the essential factors

required for smart city development, contributing to positive development, and the future trajectory of smart city evolution. Study 3 includes two questions pertaining to the role of local governments in ensuring sustainable smart city growth and factors influencing citizens' perceptions of the local government's role for smart city development. Study 4 includes questions related to the outlook for smart cities and factors perceived to positively influence their prospects. The interview, divided into four studies, was conducted with each participant, and the findings are summarized and detailed below.

Table 13. Perception on Necessity of Smart City Establishment

Q1: Do you believe that establishing a smart city is crucial in South Korea? If so, why?	
Respondent	**Answer**
Researcher A	Very important. This underscores the significance of creating smart cities, as it represents an essential response to contemporary demands for urban advancement, improved quality of life, and enhanced citizen engagement. Smart cities offer services tailored to citizens' needs, addressing gaps that traditional cities may fail to fulfill.
Researcher B	It has transcended mere importance. The establishment of smart cities is now imperative for ensuring sustainable urban growth through the utilization of ICT technology for creating and managing urban spaces.
Researcher C	Creating smart cities is crucial for efficiently utilizing limited resources through cutting-edge technology and moving away from uniform top-down urban development approaches. It signifies a move towards future cities that enhance citizens' quality of life through data-driven services across various sectors like industry, culture, and transportation.
Practitioner A	In the case of Korea, which boasts an advanced technology base like ICT, smart cities play a vital role as projects that can enhance national competitiveness.
Practitioner B	Creating a smart city is essential for addressing urban challenges like traffic congestion and environmental pollution through the utilization of cutting-edge technologies from the 4th Industrial Revolution. It aims to enhance citizens' quality of life and foster a city that generates new opportunities.
Citizen A	Creating smart cities is deemed very important due to their potential to address urban management issues stemming from population concentration through the utilization of cutting-edge technology.
Citizen B	The creation of a smart city has evolved into an essential national imperative, addressing pressing urban challenges both domestically and internationally. Issues such as urban concentration, traffic congestion, resource depletion, and climate change are escalating, necessitating innovative solutions facilitated by cutting-edge technology. Moreover, the shift towards citizen-centric governance, where communities are led by the active participation of citizens rather than centralized state control, has become crucial for individual well-being and the sustainability of communities.
Citizen C	I believe creating a smart city is crucial. It directly impacts residents' lives, fostering a tangible difference in the revitalization and maturity of the city based on the quality of services provided.
Citizen D	Creating a smart city is essential for establishing a clean urban environment system capable of mitigating fine dust resulting from abnormal climate conditions.
Citizen E	It is important. With the onset of the 4th Industrial Revolution in the 2010s, the desires for cities and the needs of citizens have become fragmented and diversified, prompting the spotlight on smart cities as a new urban model that aligns with these changes.
Citizen F	There is currently limited awareness of smart cities. However, I believe it's crucial to create cities that offer a more convenient and comfortable life by addressing environmental and urban challenges such as traffic and security, which can impact both current and future generations.
Citizen G	Given the increasing significance of urban and environmental challenges, I strongly believe in the imperative of establishing smart cities. Utilizing cutting-edge technology and data, smart cities can offer citizens a safe and comfortable living environment amidst these evolving threats.

Citizen H	Climate change is a global challenge already affecting our world, compounded by resource scarcity, particularly in our country compared to more affluent nations. With Korea grappling with issues like extreme urban population concentration, it's imperative to take proactive steps, leveraging the technologies of the 4th Industrial Revolution to create smart cities and address these pressing social concerns.
Citizen I	I believe that implementing smart city initiatives is essential for addressing diverse social challenges and advancing urban development by integrating Fourth Industrial Revolution technologies into our living environment.

Regarding the question of whether smart city creation is important in South Korea, researchers, practitioners, and citizens alike hold a positive view. They concur that the establishment of smart cities is vital and imperative for enhancing citizens' quality of life by addressing urban challenges like traffic congestion and air pollution through advanced ICT solutions. Moreover, there is consensus on the role of smart cities in fostering economic growth and fostering sustainability within society. The researchers underscore the necessity of smart city creation as a means of urban modernization, enhancing citizens' quality of life, and fostering citizen engagement through tailored services. They perceive it as a response to the evolving demands of urban growth. Meanwhile, the practitioners highlight economic benefits, emphasizing enhanced competitiveness and new opportunities from a national standpoint. Citizens, on the other hand, anticipate smart cities to address urban challenges like transportation, population density, security, and environmental issues, prioritizing tangible improvements in their daily lives through cutting-edge technology-enabled services.

Table 14. Perception on Smart City Promotional Strategy and Improvement

Q2: Do you consider the current promotional strategy regarding smart cities to be suitable? If so, why? If not, what aspects do you think need improvement?	
Respondent	**Answer**
Researcher A	The current promotional strategy is deemed inappropriate. There has been a failure to develop services that effectively educate citizens about what a smart city entails. The predominant issue lies in the top-down approach to service access, which is provider-oriented. There is a need for a paradigm shift where citizens have equal footing with the government in decision-making processes. Additionally, there is a lack of activation policies for Living Labs, which could bridge the gap between suppliers and consumers and enhance smart city awareness.
Researcher B	The current one-size-fits-all promotional strategies are largely ineffective and inadequate. To evolve into a public-led, citizen-participated, and citizen-led smart city, it is crucial to revitalize living labs. At this stage, priority should be given to learning about the technology, services, and needs of smart cities through living labs in which citizens actively participate, rather than simply promoting them. Additionally, the expertise and role of coordinators or facilitators who assist citizens in participating in living labs are essential.
Researcher C	While smart city promotion education is being offered in many local governments, the pace of service development through technological advancements often fails to match the speed and awareness of citizens' technological adaptation. As integrated platforms and mobile phones become more prevalent, smart city services struggle to offer novel experiences to citizens. Hence, there's a need to shift away from standardized local government publicity strategies and adopt customized approaches based on factors like region, age, gender, and other demographic variables.

Practitioner A	Instead of solely promoting the current concept of smart cities, there's a necessity to empirically and intensively highlight the aspects that distinguish them from traditional cities and make them more convenient through smart technologies.
Practitioner B	As cutting-edge technology becomes more pervasive due to rapid advancements, promoting smart city services and anticipating their impact becomes increasingly challenging. Many services initially introduced as part of smart city initiatives, such as electronic whiteboards, CCTV, Wi-Fi, air quality monitoring, and public bicycle systems, have now become standard in numerous cities. This ubiquity makes it difficult to offer a distinctive smart city experience. To raise citizen awareness effectively, it's essential to introduce more experiential and innovative services. Therefore, prioritizing the continuous development of user-centered services before promotion is crucial.
Citizen A	Given that smart city services are not directly accessible to citizens, it appears essential to promote them in a way that enables citizens to experience their benefits firsthand.
Citizen B	Indeed, beyond commonplace services like public Wi-Fi and bus arrival notifications, there's a lack of awareness regarding the specialized offerings of smart cities. It's crucial to develop and commercialize services that citizens can regularly engage with, irrespective of their awareness, and to actively promote these offerings.
Citizen C	I believe there's a crucial need for extensive publicity regarding smart cities. Many individuals utilize smart city-related services, yet they may not necessarily recognize them as such, perceiving them instead as services offered by local governments and public institutions. Therefore, I advocate for substantial promotion and education efforts to raise citizens' awareness of smart cities. Through these initiatives, we can gather diverse opinions and better tailor smart city services to meet the needs of our communities.
Citizen D	I agree that citizens' interest in smart cities may be low due to the lack of tangible benefits in their daily lives. While promotion and education are crucial, I believe that prioritizing the provision of a diverse range of public services that offer tangible benefits is essential. Introducing new initiatives such as electronic pads and whiteboards to reduce paper usage, comprehensive CCTV coverage in public areas, facilities to mitigate fine dust pollution, and easily accessible public transportation can significantly enhance citizens' interest and engagement with smart city initiatives.
Citizen E	Although smart cities are increasingly integrated into our daily lives, public awareness remains low. To foster broader acceptance and utilization of smart city technologies, I propose increased publicity efforts by government ministries and relevant organizations across various platforms, including social media networks (SNS).
Citizen F	Personally, I wasn't aware that Songdo, my current city of residence, was classified as a smart city. I simply regarded its services as convenient and readily available. I believe there's a necessity to enhance the promotion of smart city services, as they are more integrated into our lives than we realize and are utilized on a daily basis.
Citizen G	While the concept of a smart city appears promising and underscores the imperative for creation, it lacks a clear juxtaposition with conventional cities. I believe there's a pressing need for more proactive promotion and educational initiatives to elucidate the benefits and distinctions of smart cities compared to their traditional counterparts.
Citizen H	Given the unfamiliarity of this technology among citizens and the widening information gap across generations due to rapid technological advancement, it appears imperative to implement more tailored promotional and educational campaigns tailored to different age groups.
Citizen I	Promotional and educational efforts are essential given the close relationship between many smart city technologies and our daily lives. However, citizen awareness and participation remain low due to unfamiliarity with terminologies and operational methods. Therefore, focused initiatives are needed to bridge this gap and enhance public understanding and engagement with smart city concepts and technologies.

Researchers, practitioners, and citizens express dissatisfaction with the current promotional strategy for smart cities, noting its failure to effectively raise awareness and foster participation. The researchers advocate for a shift towards a living lab activation policy, aiming to bridge the gap between urban development stakeholders and citizens by creating platforms that enhance awareness of smart cities. They propose personalized promotional strategies tailored to factors like region, age, and gender, diverging from standardized approaches

employed by local governments. The practitioners stress the importance of ongoing development of new services that offer tangible experiences of smart city benefits to enhance promotion. Citizens echo the need for more proactive education and promotion efforts, alongside the provision of a wider range of smart services for direct user experience.

Table 15. Perception on Smart City Improvement

Q3: Do you anticipate an improvement in the evaluation, perception, and preference of areas where smart cities are implemented? If so, why?	
Respondent	**Answer**
Researcher A	Naturally, evaluations and preferences for areas where smart cities are implemented are likely to improve. However, as smart city services become integrated into daily life, citizens may find it increasingly inconvenient to live outside of a smart city environment. For instance, services such as vaccine reservations, delivery apps, and taxi apps, which were essential during the COVID-19 pandemic, have become ingrained in daily routines. If these services were suddenly discontinued, citizens would experience heightened complaints and inconveniences. Therefore, to enhance evaluations and preferences for smart city initiatives, it is crucial to develop citizen-centric services that address their needs and enhance their daily lives.
Researcher B	Certainly, citizens have preferences and expectations for smart cities, and this is linked to the perceived brand value of these cities. For instance, if a city is effectively operated and managed through a data-based integrated control center, citizens are likely to evaluate it as a more efficient, safe, and sustainable smart city in terms of transportation, environment, and safety. Consequently, more citizens would express a desire to live in such cities.
Researcher C	Citizens' preferences for smart cities, aimed at enhancing urban efficiency, may vary depending on the region they reside in and could be somewhat ambiguous initially. However, with the implementation of customized citizen services developed through citizen participation-centered living labs, these differences and ambiguities can be resolved. Consequently, regional preferences for smart cities are likely to increase over time.
Practitioner A	A clearer concept and goal for a smart city can enhance preference, yet there's a risk it might be perceived as merely a rebranding of an existing city. To sustain long-term preference, continuous technological advancement and the creation of smart services tailored to citizens' needs and satisfaction are imperative.
Practitioner B	While the image and preference for smart cities are expected to improve, there are concerns that without distinctive smart city services, the experience may not significantly differ from living in a conventional city.
Citizen A	Preference for smart city initiatives is likely to increase if policies prioritize providing services that enhance citizens' experiences.
Citizen B	Enhanced convenience facilities and improved residential spaces provided by smart cities are anticipated to boost preference among citizens. However, it's crucial to ensure that such benefits are accessible to all citizens and do not inadvertently lead to negative consequences like gentrification, which can result in rising housing prices. Implementing measures to mitigate such effects and ensure equitable access to smart city amenities is essential for sustainable urban development.
Citizen C	It is expected that preferences for smart cities will significantly improve. Even small services that enhance convenience for users are likely to contribute to a notable increase in preference for smart cities.
Citizen D	Indeed, the current smart city facilities in use are limited to services such as smart benches for cell phone charging, indicating certain limitations. However, with the development and provision of a broader range of diverse services, it is anticipated that preferences for smart cities will increase.
Citizen E	Enhancing the quality of life is a universal desire among citizens. Favorability toward a city can increase if the inconveniences of urban life are addressed through the development of smart city-specific services that offer distinct advantages compared to existing urban environments.
Citizen F	If the implementation of smart city initiatives contributes positively to aspects of the city brand, such as being perceived as pleasant, safe, and convenient, it is anticipated that the overall image and preference for the region will improve.

Citizen G	City preference is inherently tied to investment considerations, and thus, evaluations and perceptions may fluctuate depending on factors like property prices. Initially, preference may be high during the early stages of development and promotion. However, as the city matures, preference will likely be influenced by factors such as the quality of smart city services, particularly in areas like transportation infrastructure.
Citizen H	I believe that if smart cities are implemented without sufficient preparation, explanation, and promotion, negative perceptions may arise, particularly if government-led urban plans fail to demonstrate significant results. To enhance preference and evaluation, smart cities require differentiated performance strategies and services that address the diverse needs and expectations of citizens.
Citizen I	It is likely that preference for smart cities will increase over time. While there may be initial concerns due to unfamiliarity with smart city concepts, focusing on promoting the specialized services and benefits they offer could lead to a greater preference for these areas.

Researchers, practitioners, and citizens concur that evaluations and preferences for areas with smart city applications will improve. They highlight the importance of developing citizen experience services tailored to the diverse needs and lifestyles of residents, prioritizing safety and efficiency in smart city design based on data. Despite optimism, some citizens voice concerns about potential side effects like gentrification, citing examples from new urban development cases where increased real estate prices have been observed in preferred areas.

Table 16. Factors that Influence Citizens' Attitudes toward the Smart City

Q4: What factors do you believe positively influence citizens' attitudes toward smart cities, and why do you think they have such an impact?	
Respondent	**Answer**
Researcher A	I believe that open interaction (living lab), corporate participation, institutional improvement, and city brand are important, in that order. I think that open interaction (living lab), corporate participation, institutional improvement, and city brand are important in that order. As mentioned earlier, encouraging citizen participation through living labs and developing services that citizens can experience ultimately improves the quality of life for citizens and contributes to the city brand value. Among them, the need for participation by companies with cutting-edge technology and institutional improvement for service implementation will emerge, and these factors are expected to have a positive impact on citizens' attitudes toward smart cities.
Researcher B	It is believed that all the listed factors contribute positively to citizens' attitudes toward smart cities. However, certain factors may have more noticeable effects on citizens' perceptions. Among these, factors such as city brand value, public services, and open interaction are believed to have a particularly strong impact on citizens' attitudes.
Researcher C	City brand value and open interaction are seen as pivotal in shaping citizens' attitudes. These elements are deemed crucial because they signify a smart city as a desirable place for everyone to reside, where active participation from all stakeholders, including citizens, governments, companies, and experts, is encouraged to foster a city that meets their collective aspirations.
Practitioner A	I believe that smart city-related experience, environmental impact, economic value, city brand value, and public service elements are crucial. A smart city transcends mere urban development; it represents a collaborative effort involving governments, local administrations, businesses, residents, and public enterprises in ongoing operational processes. Furthermore, it embodies continuous participation, management, and cooperation, encompassing system enhancements, policy formulation, and resolution of resident concerns.
Practitioner B	Smart city-related experiences, economic value, technological development, city brand value, open interaction, and public services will positively impact citizens only when they tangibly experience increased convenience. These factors reflect citizens' perceptions of improved quality of life and are essential for fostering positive attitudes toward smart cities.

Citizen A	I believe that the role of government, technological development, institutional improvement, and corporate participation are crucial. Efficient city development relies on advancements in technology, effective institutional frameworks, active involvement of businesses, and effective governance by the government to manage urban affairs.
Citizen B	It is evident that factors such as the government's role, institutional improvement, and corporate participation play pivotal roles in shaping citizens' attitudes toward smart cities. The government's leadership is essential in driving the development of technology-centered cities, while improvements in existing systems enhance the visibility of smart city initiatives. Additionally, active involvement from technology companies contributes to the tangible outcomes and advancements in smart city projects.
Citizen C	Technological development, economic value, city brand enhancement, and improved public services are pivotal factors that positively influence citizens' attitudes toward smart cities. These elements contribute to visible effects such as enhanced public services, economic growth, and the elevation of the city's brand value through recognized cutting-edge technology.
Citizen D	The government's role, economic value, and system improvement are key factors that positively influence citizens' attitudes toward smart cities.
Citizen E	I believe that factors such as technological advancement, economic value, and open interaction play crucial roles. When urban development is driven by cutting-edge technology, leading to economic growth and more active social engagement, citizens are likely to develop positive attitudes toward smart cities.
Citizen F	It is anticipated that experiencing the clear role of the government, witnessing increased economic value, and enjoying the convenience of practical public services like real-time traffic information apps will positively influence people's attitudes toward smart cities.
Citizen G	I believe that technological development, economic value, and city brand value are important factors. Establishing a unique city brand through advanced technology and generating economic added value are expected to positively influence citizens' attitudes toward smart cities.
Citizen H	I believe economic value, social value, government role, city brand value, and technological development are crucial factors. Citizens' attitudes toward smart cities are positively influenced when these cities prioritize economic and social values, maintain them with government support, and establish a recognizable city brand based on technology.
Citizen I	I believe that smart city-related experience, the role of the government, and city brand value are the most important factors. Citizens' direct experiences and learning play a significant role in shaping their attitudes. Continued government support is essential for the sustained development of smart cities. Additionally, as the city brand value increases, citizens' positive perception of the city also tends to improve.

Researchers highlight city brand value and open interaction (living lab) as key factors positively influencing citizens' attitudes toward smart cities. They emphasize that a smart city should be a place where everyone desires to live, underscoring the importance of these elements in facilitating broad participation from citizens, government, companies, and experts in shaping a city that meets their collective preferences. Additionally, the researchers deem the enhancement of systems for active involvement of high-tech companies, essential for smart city development, as highly meaningful. These efforts can foster a sense of ownership and collaboration among stakeholders, ultimately contributing to the creation of vibrant and desirable urban environments. The practitioners emphasize that a smart city transcends mere physical infrastructure, instead embodying ongoing collaboration and participation among various stakeholders including the government, local authorities, businesses, residents, and developers. They stress the importance of sustained engagement, management, and cooperation across all aspects of city operation, encompassing system enhancements, policy development,

and addressing resident concerns. Consequently, they assert that factors such as smart city-related experiences, economic value, city brand value, open interaction, and public services will collectively foster positive attitudes among citizens toward smart cities. Citizens perceive several fundamental and visible factors as influential in shaping positive attitudes towards smart cities, including the role of government, technological advancement, economic value, corporate participation, and city brand. Of particular note is the consensus among researchers, practitioners, and citizens regarding the significance of city brand value in influencing attitudes towards smart cities. Both researchers and practitioners emphasize the importance of open interaction, particularly the role of living labs, while practitioners and citizens highlight the positive impact of economic value and city brand value on citizens' attitudes towards smart cities.

Table 17. Impact on the Quality of Life through Smart City

Q5: What factors do you recognize as having a positive impact on the quality of life of citizens through smart cities, and why?	
Respondent	**Answer**
Researcher A	Given that elements such as social value, smart city-related experiences, and environmental impact directly influence citizens' lives and are tangible, they are expected to positively impact citizens' attitudes toward their quality of life.
Researcher B	Factors such as smart city-related experiences, technological development, social values, and environmental values are believed to positively impact the quality of life of citizens. This is because citizens perceive that smart services based on technology, community formation within smart cities, and environmental protection efforts can enhance the quality and value of their lives.
Researcher C	It is believed that smart city-related experiences, social values, environmental impact, and public services are factors that positively influence the quality of life of citizens. This is because smart services that citizens can experience firsthand and smart city policies that prioritize sustainable communities and environmental values are likely to have a lasting impact on citizens' overall well-being and quality of life.
Practitioner A	Factors such as open interaction, the government's role, technological development, institutional improvement, and corporate participation are considered important. These elements are crucial as they directly impact citizens' everyday experiences and interactions with smart city initiatives.
Practitioner B	Smart city-related experiences, economic value, technological development, city brand value, public services, and open interaction will only have a positive impact if citizens can tangibly experience increased convenience. These elements effectively capture this aspect, as citizens' perceptions are shaped by the actual benefits they derive from smart city initiatives.
Citizen A	Factors such as social values, environmental impact, public services, and open interaction are perceived to positively impact the quality of life. This assessment stems from the recognition that these factors directly influence citizens' well-being and daily experiences within the smart city context.
Citizen B	It's clear that factors such as smart city-related experiences, social values, and environmental values play crucial roles in enhancing the quality of life. Citizens tend to prefer smart cities that offer tangible experiences aligned with social integration, stability, and environmental conservation efforts, even if these experiences are relatively small. These values, when integrated into daily life, contribute significantly to an improved quality of life and foster a positive perception of smart cities.
Citizen C	Indeed, factors such as social values, environmental impact, and open interaction are pivotal in enhancing quality of life within smart cities. These factors share a future-oriented perspective, emphasizing the importance of sustainable community engagement, environmental conservation, and collaborative interactions among citizens, which collectively contribute to a more vibrant and fulfilling urban experience.

Citizen D	I believe that the factors mentioned, including smart city-related experiences, social values, city brand, public services, and environmental values, indeed have a profound positive influence on enhancing the quality of life for citizens.
Citizen E	I firmly believe that by emphasizing smart city-related experiences, enhancing city brands, and improving public services, we can significantly enhance the quality of life in a smart city, consequently increasing citizens' favorability towards it.
Citizen F	By prioritizing smart city-related experiences, city brands, and environmental values, smart cities can create a convenient, safe, and pleasant living environment, leading to a significant improvement in the quality of life for citizens.
Citizen G	I believe that smart city-related experiences, social values, and environmental impact factors are crucial. This is because experiencing smart city services aimed at improving social cohesion and environmental sustainability through technology and data has a tangible impact on citizens' quality of life.
Citizen H	I believe that smart city-related experiences, social values, and environmental impacts are factors that positively influence the quality of life of citizens. While not always directly tangible, I think that citizens' quality of life improves as they encounter more services that prioritize societal well-being and environmental considerations.
Citizen I	I believe that smart city-related experiences, technological development, and public services, in that order, have a positive impact on the quality of life. I have considered these factors to be closely related to citizens' lives, as they directly influence the experiences, technological advancements, and public services that contribute to an improved quality of life

Researchers assert that factors such as smart city-related experiences, social values, and environmental values positively impact citizens' quality of life. They highlight the significance of smart services that citizens directly experience, community-building within smart cities, and sustainable environmental practices in enhancing life satisfaction. The practitioners emphasize smart city-related experiences, open interaction, and active cooperation as factors that improve quality of life by enhancing convenience and fostering community engagement. Citizens also recognize the positive impact of smart city-related experiences, social values, environmental impact, and public services on their quality of life, citing improved social relationships and environmental conservation as key contributors to enhanced well-being. Researchers, practitioners, and citizens collectively agree that smart city-related experiences will exert the most significant impact on citizens' quality of life within smart cities. However, researchers and citizens assign greater importance to social and environmental values compared to practitioners. This finding suggests a need for greater consideration of social and environmental factors in policy-making and development processes related to smart cities. By prioritizing these values, policymakers can ensure that smart city initiatives align more closely with the needs and preferences of citizens, thereby enhancing overall well-being and sustainability within urban environments.

Table 18. Factors that Influence the Development of Smart Cities

Q1: What factors do you acknowledge as having a positive impact on the development of smart cities, and why?	
Respondent	**Answer**

Researcher A	Government support in terms of systems, local government backing, and the active participation and collaboration of various stakeholders, encompassing both public and private sectors, are deemed critical factors. These elements are perceived as indispensable for the development of smart cities, as they provide the necessary framework and resources for advancement in this domain.
Researcher B	User-centered technical support, government backing, local government support, and the involvement of smart city experts are all crucial. Government support, both financially and in terms of policy, is essential for the creation, operation, and management of smart cities. Local governments play a key role in implementing smart city initiatives within their regions. Furthermore, the expertise and guidance provided by smart city experts contribute to the effective development and implementation of smart services.
Researcher C	Government support, particularly in terms of budget allocation, and the capabilities and support provided by local governments are regarded as the most critical factors for smart city development. The availability of adequate budgetary resources and the commitment of local government leaders greatly influence the implementation and success of smart city policies. Moreover, the competence and assistance of local government officials play a crucial role in driving smart city initiatives forward. Training programs aimed at enhancing the capabilities of these officials contribute to their competitiveness in implementing smart city policies. Additionally, competition among local governments to offer innovative smart city services is on the rise.
Practitioner A	I believe that government support, local government support, user-centered technical assistance, and increased participation by private companies will positively impact the development of smart cities. This is because ongoing government backing, effective management by local authorities, and active involvement of private enterprises and citizens are essential even after the establishment of a smart city.
Practitioner B	User-centered technical support, government backing, and increased participation by private companies are crucial. Government support is essential for setting the right direction and creating an environment where private companies can contribute effectively. However, it's important to ensure that private sector involvement aligns with the core objectives of smart city development, prioritizing citizen convenience and usability of services.
Citizen A	User-centered technical support, government backing, and local government support are crucial for smart city development. Ultimately, the success of smart city initiatives hinges on user-centric technology services, financial and administrative support from the government, and assistance from local governments, which play a pivotal role in city operations and management.
Citizen B	To develop a citizen-centered smart city, continuous provision of user-centered technical support, government support, and local government support is essential. Citizens are attracted to easier and more intuitive technologies, making user-centered technical assistance crucial. Additionally, the role of the government and local governments in creating and operating cities for development is paramount.
Citizen C	I believe that user-centered technical support, increased participation of private companies, and support from local governments will positively impact the development of smart cities. Ensuring convenience and ease of use for citizens is crucial, which necessitates user-centered technical assistance. Moreover, the involvement of private companies with cutting-edge technology is essential for enhancing the quality of smart cities. Additionally, sustained financial and administrative support from local governments can further facilitate smart city development.
Citizen D	For the development of smart cities, I believe that user-centered technical support, government support, and increased participation of private companies are paramount.
Citizen E	I believe that user-centered technical support and local government support are crucial elements for the development of smart cities. From a citizen's perspective, all services must be user-centered and convenient to use. While participation by private companies is important, the pursuit of profit can sometimes obscure the direction of smart cities. Therefore, I believe that the support role of local governments is vital in maintaining this direction and reflecting citizens' opinions.
Citizen F	I agree. User-centered technical support, government support, and expanded participation by private companies are indeed crucial elements for the development of smart cities. Continuous support from the government is essential to provide the necessary infrastructure and regulatory framework, while the participation of private companies brings in innovative solutions and investment. Together, these elements can drive sustainable development in smart cities.
Citizen G	I completely agree. User-centered technical support, government support, expanded participation by private companies, and local government support are all crucial for the successful development of smart cities. Without these elements working together, it’s challenging to create a sustainable and

	innovative urban environment that truly benefits its residents and meets the goals of a smart city initiative.
Citizen H	Absolutely, user-centered technical support, expanded participation of private companies, and support from local governments are all integral to the development of smart cities. By prioritizing user needs and experiences, leveraging the expertise and innovation of private companies, and receiving backing from local governments, smart cities can effectively address urban challenges and enhance the quality of life for residents.
Citizen I	I think user-centered technical support, local government support, and government backing are crucial for smart city development. Prioritizing technology that directly benefits users ensures the effectiveness of smart city solutions. Moreover, sustained support from local and national governments is essential for the continuous advancement of these initiatives.

Researchers and practitioners identify various factors that positively influence the development of smart cities. Researchers prioritize government support and local government capabilities and support due to their significant influence on policy implementation and performance. They also emphasize the importance of co-creation through expert and stakeholder participation to enhance the direction and efficiency of smart services. On the other hand, the practitioners rank government support, local government support, user-centered technical assistance, and increased private sector involvement as key factors. They stress the necessity of ongoing government backing, effective local government management, and continuous innovation facilitated by private sector initiatives and citizen engagement for sustained smart city development. Citizens prioritize user-centered technical support as the most significant element for smart city development, indicating their strong desire for active involvement in shaping a citizen-centric urban environment. Additionally, they emphasize the importance of continuous government support, increased participation of private companies, and local government backing to ensure that smart cities evolve into sustainable and innovative urban centers, rather than remaining as conventional cities.

Table 19. Perception on the Development of Smart Cities

Q2: Do you anticipate that smart cities will continue to advance? If so, why?	
Respondent	**Answer**
Researcher A	Smart cities will undoubtedly continue to develop. However, sustained progress hinges on the active engagement of various stakeholders, including government and private sectors, in innovative activities.
Researcher B	Certainly. The evolution of smart cities is an inevitable progression, intertwined with technological and societal advancements. The crucial aspect lies in the direction, pace, and manner in which this development unfolds.
Researcher C	Just as U-city evolved into a smart city, I anticipate that smart cities will also continue to advance. This progression will be driven by the ongoing development of cutting-edge technologies that enable the creation of efficient cities with limited resources, along with the refinement of services that cater to citizens' needs. However, the pace of this development will hinge on factors such as the strategic utilization of technologies, policy enhancements, and the establishment of cooperative frameworks among the government, local administrations, private sector, and citizens.

Practitioner A	Given that a city functions as a vast organism and a community that evolves collectively, the development of smart cities is anticipated to be characterized by gradual progress and continuous growth, rather than swift advancement.
Practitioner B	Smart cities will persist in their development trajectory as platforms for implementing cutting-edge technologies and solutions aimed at enhancing the lives of citizens and addressing diverse urban challenges. This evolution will prioritize increasing citizens' perceived satisfaction and further enhancing the operational efficiency of cities.
Citizen A	Smart city development will persist, driven by citizens' demands for an enhanced quality of life and the imperative to foster sustainable environments.
Citizen B	Cities have evolved despite numerous socioeconomic challenges, and it is anticipated that smart cities will advance even further as citizen awareness of communal issues grows alongside technological advancements.
Citizen C	I anticipate ongoing development in smart cities. With the continuous development and introduction of various new technologies both domestically and internationally, smart cities are expected to become increasingly sophisticated.
Citizen D	Indeed, as people's lifestyles increasingly prioritize efficiency, there's a growing demand for more accurate information and urban systems that cater to real-life needs. Leveraging this trend, smart cities are anticipated to continue expanding.
Citizen E	Absolutely, smart cities hold the promise of providing enhanced convenience for citizens while also serving as solutions to pressing urban challenges. With these benefits in mind, it's likely that smart cities will continue to develop and gain popularity in the future we envision
Citizen F	Indeed, smart cities are positioned to evolve continuously as they address pressing urban challenges like traffic congestion, population decline, environmental degradation, and safety concerns during emergencies.
Citizen G	Absolutely, the rapid advancements in cutting-edge technologies like big data and artificial intelligence (AI) are expected to drive the continued development of smart cities.
Citizen H	I agree. The ongoing advancement of technology provides a solid foundation for the continued development of smart cities. As these cities evolve, they offer opportunities to harness new technologies, driving further innovation and improvement. This cycle of development is likely to persist, creating a positive feedback loop for the continuous enhancement of smart cities.
Citizen I	Absolutely. The relentless progress of technology will undoubtedly propel the ongoing development of smart cities, further enhancing their influence on the daily lives of citizens.

Researchers, practitioners, and citizens anticipate significant development potential for smart cities, driven by advancements in cutting-edge ICT technologies such as AI and Big Data. They envision more convenient urban living environments resulting from efficient urban development. Key to this vision, researchers emphasize, is collaborative participation and innovative cooperation among government entities, local governments, the private sector, and citizens. They assert that the involvement of stakeholders will shape the trajectory and pace of smart city development. Both practitioners and citizens concur, foreseeing smart cities evolving to address urban challenges through technological innovations and the provision of highly valued citizen-centric services, ultimately contributing to the realization of a sustainable society.

Table 20. Perception on the Role of Local Governments in Creation of Smart Cities

Q1: Do you consider the creation of smart cities to be a crucial responsibility of local governments? If so, what do you believe is the rationale behind this perspective?	
Respondent	**Answer**
Researcher A	Local governments play a pivotal role in smart city development as they are responsible for managing the areas where cities are constructed and overseeing the lives of citizens, making their involvement indispensable in discussions surrounding smart cities.

Researcher B	Local governments are considered pivotal as they serve as the primary implementers of smart city initiatives. The effectiveness and success of such projects often depend on the capabilities and commitment of the local government in executing these plans.
Researcher C	Indeed, the role of local governments is deemed paramount in the creation of smart cities. With authority over city planning and operational management, local governments are responsible for a wide array of tasks, including operating integrated platforms for public-private collaboration, developing innovative services, and proposing smart city policies. Disparities in the evaluation of smart city creation often stem from differences in the preparedness and systematic approach of local governments to this endeavor.
Practitioner A	Absolutely, the local government plays a pivotal role in driving the creation of smart cities, starting from the urban planning phase. Their leadership and involvement are crucial for setting the vision, coordinating stakeholders, and implementing initiatives that align with the smart city agenda.
Practitioner B	I agree. The role of local governments is indeed crucial in the creation of smart cities. They are responsible for urban development and management, making their involvement indispensable in driving digital transformation and implementing ICT technologies for smarter city operations.
Citizen A	Certainly, the commitment and proactive involvement of the local government are paramount in the creation and effective management of a smart city. Their willingness to embrace innovation, invest in smart infrastructure, and collaborate with various stakeholders are crucial factors that drive the success of smart city initiatives.
Citizen B	Indeed, the role of local governments is pivotal in the growth and development of smart cities. They oversee various aspects such as implementing local systems, fostering collaboration with technology companies, and promoting civic engagement. The establishment of specialized departments within local governments demonstrates a proactive approach towards embracing smart city initiatives and driving their progress forward.
Citizen C	I believe it's an essential role. A smart city that caters to the needs of citizens can only be realized when local governments take the lead in providing diverse city functions and public services.
Citizen D	I believe it's a crucial role. Given that the local government is responsible for operating and managing urban management systems, efforts should be directed towards actively implementing smart city systems to enhance the services offered to citizens.
Citizen E	I believe it is one of the pivotal roles. In the current landscape of digital transformation and the application of ICT technology in urban development and management, the role of local governments overseeing city development and operations management is inherently significant.
Citizen F	The role of local governments in managing and operating cities is crucial for the growth of smart cities aimed at addressing urban challenges.
Citizen G	Local governments, being responsible for city operation and management, naturally play a critical role in the development of smart cities. This includes ensuring the security of personal information, which they may handle more effectively than the private sector.
Citizen H	I agree. Local governments play a crucial role in orchestrating the development of smart cities, ensuring effective coordination among various stakeholders, including private companies.
Citizen I	Absolutely, the development of smart cities not only improves the quality of life for citizens but also enhances the efficiency and effectiveness of local government operations. Thus, it's indeed a significant responsibility of local governments to lead and facilitate the creation and development of smart cities.

Researchers, practitioners, and citizens unanimously emphasize the crucial role of local governments in the creation and development of smart cities. Researchers stress that discussions about smart cities are incomplete without considering local governments, which serve as pivotal actors in city creation, operation, and management. Notably, local governments operate platforms for innovative ideas that foster public and private participation, with their effectiveness and execution capabilities varying based on their capacities and roles. Practitioners highlight that local governments are engaged from the urban planning stage and play a vital role as entities responsible for smart city construction and operation. Similarly,

citizens recognize the significance of local governments in delivering citizen-centric services within smart cities and managing city affairs. They prefer local governments to effectively coordinate private sector involvement and oversee data security, prioritizing citizen interests over commercial objectives.

Table 21. Factors that Influence Local Government in Growth of Smart Cities

Q2: What factors do you believe positively influence citizens' perception of the role of local governments in the growth of smart cities? What is the reasoning behind this perception?	
Respondent	**Answer**
Researcher A	Efficient management and operation by local governments, along with active cooperation among stakeholders, are crucial factors in the development of smart cities. Ultimately, it falls on the local government to manage the city and implement services that directly impact citizens. This requires collaboration among various sectors including government bodies, technology firms, academic institutions, research centers, and the public to develop customized services that promote sustainability and meet the needs of citizens.
Researcher B	The creation of a smart city fundamentally revolves around the creation and management of urban spaces. In this context, the role of local governments is indispensable, encompassing efficient management and operation, as well as collaboration with various stakeholders. Their involvement is crucial and is expected to exert significant influence on the process.
Researcher C	In relation to the essence of smart cities and the responsibilities of local governments, we posit that the effective management and operation of smart city initiatives by local authorities, coupled with their proactive collaboration with stakeholders, will notably enhance citizen awareness.
Practitioner A	The efficient management and operation of smart cities by local governments, along with their proactive engagement with stakeholders, are indeed crucial for enhancing citizen awareness. This shift towards smart city management, relying on data and ICT, requires innovative thinking and active involvement from local authorities to truly succeed.
Practitioner B	Efficient management and operation by local governments, coupled with active collaboration with stakeholders, are indeed pivotal. Local governments play a crucial role in maintaining and managing the city, establishing governance structures, and fostering collaboration with stakeholders for effective data services and smart city initiatives.
Citizen A	When discussing the role of local governments in the development of smart cities, I emphasize the significance of efficient management and operation by local governments, as well as their active collaboration with stakeholders. These factors are crucial in ensuring effective governance, fostering innovation, and driving forward smart city initiatives to benefit the community.
Citizen B	In the context of smart city growth, we see that efficient management and operation of local governments, coupled with proactive engagement and cooperation with stakeholders, will indeed foster positive citizen awareness.
Citizen C	Local governments, as the entities responsible for city creation, must continuously maintain and develop urban spaces. Moreover, facilitating collaboration among stakeholders from various sectors is also a pivotal role of local governments.
Citizen D	I believe that efficient management and operation of local governments, coupled with effective promotion efforts, will positively influence citizens' perception of the role of local governments.
Citizen E	I believe that the local government's ability to efficiently manage and operate a smart city plays a significant role and is crucial in the development of smart cities. Promoting an efficient and systematic urban management process can enhance citizens' responsiveness and engagement with smart city initiatives.
Citizen F	To ensure the continued growth of smart cities, effective management and operation by local governments are essential. Encouraging active participation and cooperation from stakeholders, including private companies and citizens, can positively influence citizens' perception of the role of local governments in driving smart city initiatives.
Citizen G	Efficient management and operation by local governments, coupled with active collaboration with stakeholders, are pivotal for shaping positive citizen perceptions. Neglecting these aspects could hinder the effective development and sustainability of smart cities, highlighting the critical role of local government engagement and cooperation.

Citizen H	I agree. Active cooperation with stakeholders and efficient management and operation by local governments are essential for the successful development of smart cities. Without effective collaboration with stakeholders, including the private sector and citizens, the implementation of smart city initiatives can face significant challenges.
Citizen I	Absolutely. Active promotion by local governments is crucial for ensuring that citizens are aware of and engaged with smart city initiatives. Effective communication and outreach campaigns can help educate citizens about the benefits of smart city technologies and services, encourage their participation, and gather valuable feedback to improve and tailor these initiatives to better meet the needs of the community.

Researchers, practitioners, and citizens all agree on the specific role of local governments in the growth of smart cities. They highlight the importance of local government efficiently managing and operating cities while actively cooperating with stakeholders, which ultimately shapes citizen perceptions positively. Researchers and practitioners stress the role of local governments in ensuring the efficient city management and operation, as well as fostering active cooperation among stakeholders from both the public and private sectors. Citizens also acknowledge the significance of local governments in facilitating cooperation among various stakeholders involved in city management and creation. Moreover, they advocate for more proactive promotion efforts by local governments to further enhance citizen awareness and engagement in smart city initiatives.

Table 22. Factors that Influence Smart City Prospects

Q: What factors do you believe positively influence the prospects for smart cities? Why do you think they have a positive impact?	
Respondent	**Answer**
Researcher A	Expansion of public services, economic factors, social factors, and environmental factors, alongside the implementation of citizen-experience-centric services, will significantly influence the prospects of a smart city. Moreover, considerations such as job creation, enhancing quality of life, establishing trust in data, and adapting to environmental changes will also shape the outlook for smart cities.
Researcher B	The driving force behind smart city development, economic factors, and environmental considerations are deemed crucial. Collaboration between the government and local authorities remains vital for the creation and management of smart cities. Additionally, involvement of the private sector is key for job creation and local economic revitalization, while efforts towards energy efficiency and environmental sustainability are recognized as essential for societal well-being.
Researcher C	In the context of smart city outlooks, environmental considerations are increasingly prominent, aligning with both domestic and international policy trends. There's a growing expectation for smart cities to offer environmental solutions, reflecting a sustainable approach to economic and social development. This includes economic factors like local economy revitalization and job creation, as well as social aspects such as fostering trust through information sharing and community engagement within smart city policies.
Practitioner A	I believe that the expansion of public services, securing momentum, and economic factors will positively impact the prospects for smart cities. In practical smart city implementations, there's increasing participation from various companies through open platforms, utilizing public data. Economic factors, including job creation and related fields, are deemed crucial. Additionally, securing the driving force to establish and implement smart city policies, such as system improvements and attracting companies, is considered an essential element.
Practitioner B	I believe that economic factors, expansion of public services, and environmental factors will have a positive impact. Ultimately, for the continued development of smart cities, private companies must create opportunities, and data-based public services that prioritize environmental improvement and citizens' quality of life, such as energy savings, must be continuously developed and expanded.

Citizen A	I believe that the expansion of public services, environmental factors, and the securing of a driving force will have a positive impact. Regarding the outlook for smart cities, environmental preservation is an unavoidable policy for sustainable cities, and the development and provision of services that can improve the quality of life for citizens will be essential through the expansion of public services. To achieve this, it is important to secure continuous driving force.
Citizen B	The prospects of smart cities will be significantly influenced by economic, social, and environmental factors. This includes the expansion of smart city-specific public services, which enhance citizens' urban experience and contribute to a better quality of life. Additionally, initiatives aimed at fostering safer social communities and promoting environmental sustainability will play crucial roles in shaping the future of smart cities.
Citizen C	Expanding various data-based public services accessible to diverse demographics can significantly enhance the prospects of smart cities. This expansion not only improves the overall urban experience but also contributes to the city's development in a positive direction. Additionally, increasing economic value through initiatives like job creation can further bolster the attractiveness of smart cities, attracting more residents and fostering new avenues for growth.
Citizen D	Positive factors for the prospects of smart cities include strategic promotions by the government and local authorities, regulatory enhancements, the attraction of companies to drive innovation, and the provision of efficient data-based public services. These elements collectively contribute to the advancement and attractiveness of smart cities, ensuring sustainable growth and development.
Citizen E	Amidst a prevailing sense of global economic uncertainty, I believe that demonstrating economic benefits such as job creation resulting from the development of smart cities will positively influence citizens' perceptions of smart city prospects.
Citizen F	Expanding public services and actively incorporating environmental considerations, I believe, will garner a more favorable response toward a nature-friendly smart city that prioritizes citizen participation.
Citizen G	I believe that in the future, nature-friendly smart cities that prioritize securing driving forces, expanding public services, and incorporating environmental factors will gain more attention. Without government support and cooperation from local governments, I believe we will lack the power to lead smart cities in the future.
Citizen H	I believe that economic factors, securing momentum, and expanding public services will positively influence the success of smart cities. Economic effects are crucial for the successful initiation and sustainability of smart cities. Moving forward, securing momentum through regulatory improvements and attracting companies will be pivotal for smart city success. Moreover, providing data-driven public services can significantly enhance citizen satisfaction.
Citizen I	I believe that economic factors, environmental factors, and promotional strategies are important in that order. Economic factors, such as job creation and economic growth, are universal concerns that impact citizens of all age groups. Environmental factors, including sustainability and eco-friendliness, are also significant considerations for a better quality of life. Additionally, effective promotional strategies are essential to highlight the positive aspects of smart cities and garner support from citizens.

Regarding the prospects for smart cities, researchers underscore the positive impact of economic, social, and environmental factors. They prioritize job creation, community integration, trust-building among members, and environmental conservation policies as key considerations. Expansion of public services that directly benefit citizens and sustained support from government and local authorities, without losing momentum, are highlighted as crucial for smart city prospects. The practitioners echo the importance of economic factors, expansion of public services, and environmental considerations. They emphasize the need for private companies to create economic opportunities and for continuous development of data-driven public services aimed at enhancing environmental sustainability and citizens' quality of life, including energy-saving initiatives. Citizens' opinions on the prospects for smart cities vary.

Generally, they believe that the expansion of tangible public services to enhance quality of life, economic factors promoting a livable society through active business activities, and environmental considerations for sustainability are key drivers for smart city prospects. Additionally, citizens stress the importance of continuous support from government and local authorities, as well as effective promotional policies encouraging citizen participation, as indispensable factors for creating and advancing sustainable smart cities.

Expert groups (researchers, practitioners) and citizens generally responded positively to all inquiries regarding the necessity of smart cities, the insufficiency of the current promotional strategy, the growing preference for areas where smart cities will be established, and the development and prospects of smart cities. For other inquiries, Table 23 outlines the consensus and disparities within the expert group.

Table 23. Comparative Analysis by Expert Group (Researchers vs. Practitioners)

Questions	Consensus among Researchers and Practitioners	Researchers	Practitioners
Q1: **What factors influence citizens' awareness of smart cities?**	· City brand value · Public service · Open interaction	· City brand value · Public service · Institutional improvement · Corporate participation · Open interaction (living labs)	· Smart city-related experience · Technical development · Economic value · City brand value · Public service · Open interaction
Q2: **What factors influence the quality of life of citizens in smart cities?**	· Smart city-related experience · Technical development · Public service	· Smart city-related experience · Technical development · Social value · Environmental value · Public service	· Smart city-related experience · Technical development · Public service · Open interaction
Q3: **What are the factors that have a positive impact on the development of smart cities?**	· User-centered technical support · Government support · Local government support	· User-centered technical support · Government support · Expert group participation · Local government support	· User-centered technical support · Government support · Corporate participation · Local government support
Q4: **What are the factors that have a positive impact on the role of local governments in smart city growth?**	· Efficient management & operation · Active collaboration with stakeholders	· Efficient management & operation · Active collaboration with stakeholders	· Efficient management & operation · Active collaboration with stakeholders
Q5: **What are the factors that have a positive impact on the prospects of smart cities?**	· Driving forces · Expansion of public services · Economic value · Environmental value	· Driving forces (government & local government support) · Expansion of public services · Economic value · Social value · Environmental value	· Driving forces (institutional improvement, corporate participation) · Expansion of public services · Economic value · Environmental value

As depicted in Table 23, practitioners appear to prioritize practical elements, such as experience and technological advancements in smart cities, more than researchers, who may emphasize broader concepts or theoretical frameworks. Furthermore, concerning the quality of

life in smart cities, researchers seem to accentuate sustainable software aspects more than practitioners, as they prioritize social and environmental values as significant factors. When considering the prospects for smart cities, researchers appear to prioritize social values that foster interaction among city members, particularly citizens, and contribute to the establishment of sustainable, thriving communities as key factors.

Table 24 delineates the consensus and discrepancies between the expert group and citizens.

Table 24. Comparative Analysis (Expert Group (Researchers and Practitioners) vs. Citizens)

Questions	Consensus among Researchers and Practitioners	Expert Group	Citizens
Q1: What factors influence citizens' awareness of smart cities?	· Technical development · Economic value · City brand value · Corporate participation	· Smart city-related experience · Technical development · Economic value · City brand value · Public service · Institutional improvement · Corporate participation · Open interaction	· Government support · Technical development · Economic value · City brand value · Corporate participation
Q2: What factors influence the quality of life of citizens in smart cities?	· Smart city-related experience · Social value · Environmental value · Public service	· Smart city-related experience · Technical development · Social value · Environmental value · Public service · Open interaction	· Smart city-related experience · Social value · Environmental value · Public service
Q3: What are the factors that have a positive impact on the development of smart cities?	· User-centered technical support · Government support · Corporate participation · Local government support	· User-centered technical support · Government support · Expert group participation · Corporate participation · Local government support	· User-centered technical support · Government support · Corporate participation · Local government support
Q4: What are the factors that have a positive impact on the role of local governments in smart city growth?	· Efficient management & operation · Active collaboration with stakeholders	· Efficient management & operation · Active collaboration with stakeholders	· Efficient management & operation · Active collaboration with Stakeholders · Active promotion
Q5: What are the factors that have a positive impact on the prospects of smart cities?	· Driving forces · Expansion of public services · Economic value · Social value · Environmental value	· Driving forces · Expansion of public services · Economic value · Social value · Environmental value	· Driving forces (government & local government support) · Expansion of public services · Economic value · Social value (civic participation) · Environmental value

As depicted in Table 24, concerning citizens' awareness of smart cities, the expert group highlighted experience and public services associated with smart cities as significant factors, whereas citizens emphasized the importance of government support. Consequently, the expert group inferred that enhancing smart city service experience could enhance citizen awareness, while citizens perceived a deficiency in government support or insufficient publicity for smart

cities. Furthermore, regarding citizens' awareness of quality of life in smart cities, the expert group identified technological development and open interaction as significant factors, implying that these elements are crucial for smart cities unlike citizens. This underscores the expert group's emphasis on fostering development through collaboration between the private sector and the government.

IV. Conclusion

4.1. The Summary of Findings

The purpose of this study is to investigate the factors that influence successful smart city initiatives along with citizens' awareness and attitudes toward smart cities, using smart city case studies and conducting in-depth interviews. This study delves into the factors influencing the growth and development of sustainable smart cities by examining case studies of successful smart cities both domestically and internationally, alongside those in need of improvement. This study initially examines smart city case studies categorized as successful, unsuccessful, or requiring improvement. Among successful cases, analysis was conducted on Amsterdam, Barcelona, London, and New York. Toronto was examined as a case of failure. Additionally, smart city initiatives in need of enhancement, such as U-City, Songdo, and Sejong in South Korea, were investigated. The research primarily concentrates on the provision of public services facilitated by ongoing technological advancements, the policy frameworks and support from local governments, collaboration between the public and private sectors, economic, social and environmental consideration, as well as fostering open interaction conducive to the sustainable development of smart cities. The findings underscore that achieving this goal is contingent upon effectively integrating various factors, including citizen participation as a pivotal factor.

Moreover, this study aims to provide insights for policymaking and adjustments related to smart cities in South Korea through qualitative research. This investigation includes exploring experts and citizen's perceptions regarding the impact of smart cities, the factors contributing to smart city growth, the role of local governments in fostering sustainable smart cities, and the future prospects of smart city development. This exploration is conducted through in-depth interviews with researchers, practitioners, and citizens actively involved in smart city initiatives.

Firstly, regarding factors influencing citizens' awareness of smart cities in Study 1, both

researchers and practitioners highlighted factors such as city brand value, public services, and open interaction. Researchers emphasized institutional improvement and corporate participation as significant factors, while practitioners anticipated that smart city-related experiences, technological development, and economic value would have a notable impact. Both experts and citizens identified several factors that would influence smart cities, including technical development, economic value, city brand value, and corporate participation. The experts emphasized smart city-related experience, public service, institutional improvement, and open interaction as crucial factors, while citizens regarded government support as important. This result indicates a consensus among both experts and citizens regarding the importance of factors such as technical development, economic value, city brand value, and corporate participation in the establishment of smart cities. Furthermore, it underscores the nuanced perspectives: while the experts emphasize smart city-related experience, public service, institutional improvement, and open interaction as crucial factors for smart city development, citizens prioritize government policy support. This highlights a shared understanding of key factors while also acknowledging nuanced priorities.

Furthermore, regarding factors influencing the quality of life in smart cities Study 1, both researchers and practitioners identified elements such as smart city-related experiences, technological development, and public services. Researchers placed greater emphasis on social and environmental values, while practitioners anticipated that open interaction would have an impact on quality of life. Both expert groups and citizens identified several factors that would impact smart cities, including smart city-related experience, social value, environmental value, and public service. The expert group also emphasized technical development and open interaction as significant elements. This finding indicates a common perspective among both expert groups and citizens that factors such as smart city-related experience, social value, environmental value, and public service contribute positively to the quality of life within smart cities. The expert group's emphasis on technical development and open interaction suggests that these factors are considered crucial for fostering the growth of a sustainable smart city.

Secondly, regarding factors influencing the development of smart cities in Study 2, both researchers and practitioners highlighted the importance of user-centered technical support, government support, and local government support. Researchers emphasized the significance of expert group participation, while practitioners anticipated that active involvement from companies would impact the development of smart cities. Both expert groups and citizens agree that user-centered technical support, government support, corporate participation, and local

government support are influential factors. Additionally, the expert group highlighted the importance of expert group participation. This result highlights the widespread recognition that factors such as user-centered technical support, government support, corporate participation, and local government involvement are essential for the development of smart cities.

Thirdly, regarding the preferred role of local government in the growth of smart cities in Study 3, both researchers and practitioners emphasized the importance of efficient management and operation, as well as active collaboration with stakeholders, as key roles for local governments to fulfill. Both expert groups and citizens agree on the importance of efficient management and operation, as well as active collaboration with stakeholders, as key roles of local government. Citizens also emphasized the need for more active promotional activities by local governments. This result indicates that there is alignment between the perceptions of experts and citizens regarding the role of local governments in the growth of smart cities. However, it also suggests that citizens perceive local governments' promotional efforts as insufficient.

Lastly, regarding the prospects for smart cities in Study 4, both researchers and practitioners identified several key factors contributing to positive outcomes. These include driving forces, expansion of public services, economic value, and environmental value. Additionally, researchers highlighted the importance of social value as another significant factor shaping the future of smart cities. Both expert groups and citizens commonly highlighted factors such as driving forces, expansion of public services, economic value, social value, and environmental value as influential. Citizens particularly emphasized the importance of support from the government and local governments as a driving force. This result highlights the shared recognition among both expert groups and citizens regarding the significant impact of driving forces, expansion of public services, economic value, social value, and environmental value on the prospects of smart cities. Additionally, citizens perceive that continuous support from the government and local governments is essential for the bright prospects of smart cities.

Through a triangular method encompassing literature reviews, case studies, and in-depth interviews, this study has identified the key concepts and influential factors essential for the realization of smart cities as follows. Looking at existing studies that have discussed the main concepts of smart cities and the essential factors dealt with in their development process, it is evident that the elements necessary for the realization of smart cities are revealed either individually or in common. Numerous existing studies attempting to define key concepts of smart cities have expanded the scope to include perspectives such as sustainability, quality of

life, and public services for citizens, while also emphasizing factors essential to smart cities (Hara et al., 2016; Ahvenniemi et al., 2017). A smart city, created based on cutting-edge ICT technology, goes beyond technical operation to encompass economic and social dimensions and it ultimately improves the quality of life and elevates economic, social, environmental, and cultural aspects of urban public services (Zygiaris, 2013; Siemens, 2017). In line with these smart city concepts and goals, Giffinger et al. (2007) and Lombardi et al. (2012) found that the key elements for realizing a smart city are economic factors such as innovative spirit, social governance formed by citizen participation, application and accessibility of cutting-edge technology, creation of a sustainable environment, and public policy that prioritizes quality of life. These elements have been emphasized from a structural perspective of a smart city. In addition, Chourabi et al. (2012) mentioned the formation and involvement of the citizen community, a dedicated smart city organization, and the role of the government in executing technology and related policies as elements crucial for the realization of smart cities.

Looking at the aspects of smart cities promoted by developed countries, it is evident that the main elements of smart cities emphasized in existing studies are clearly revealed. Europe and the United States offer diverse services that integrate culture and art with the aim of fostering eco-friendly urban development and these initiatives prioritize private sector involvement in the efficient management and optimal utilization of existing urban infrastructure to enhance citizens' quality of life (UN Economic and Social Council, 2016). Amsterdam is actively transitioning to eco-friendly energy sources to mitigate climate change, forging over 70 partnerships with various stakeholders, including CISCO and IBM. These collaborations focus on key areas like living, working, mobility, public amenities, and open data. Barcelona, known for prioritizing citizens' well-being and economic advancement, has established a conducive legal environment for fostering private-public partnerships among stakeholders, further enhancing its commitment to improving quality of life. The smart city initiatives in Amsterdam and Barcelona highlight the significance of collaboration and government policy in driving urban innovation. Each partner operates autonomously within the innovative framework set by the government, aligning their activities with the overarching goals of enhancing quality of life and promoting social governance among citizens (Bakici et al., 2013). New York City has implemented a localized strategy focused on digital advancements, tailored to its unique resources and needs (Angelidou, 2014). Engaging both private and public stakeholders, including residents, officials, and technology experts, the city gathers insights and suggestions via online platforms, facilitating participatory decision-

making (The City of New York, 2011). This collaborative approach has proven highly effective in advancing New York's digital infrastructure.

In-depth interviews with expert groups, including researchers, practitioners, and smart city citizens, revealed that key elements crucial for the realization and development of smart cities, as identified in existing studies and smart city cases, were consistently emphasized. The expert group highlighted several essential elements for a smart city focused on enhancing quality of life. These include technological advancement, emphasis on social and environmental values, promotion of open collaborative interactions such as living labs, and the development of citizen-centered public services. Both expert groups and citizens stressed the importance of several factors for the development of smart cities, including user-centered technical support, government backing, corporate engagement, and local government involvement. They anticipate that smart cities will evolve further through enhancements in technological infrastructure, sustained government policy, local government's role and active citizen engagement. In the context of smart city growth, local governments play a crucial role in preparing organizations and personnel for efficient city operation and management, as demanded by smart city dynamics. It is imperative for local governments to cultivate capabilities that foster collaboration among diverse stakeholders. Experts and citizens both emphasized the significance of continuous policy support and efforts from national and local governments for the prospects of smart cities. They stressed the importance of integrating policies that consider social, economic, and environmental factors into public services consistently.

In conclusion, the development and growth of smart cities striving for sustainability and enhanced quality of life hinge on several key elements. These include the advancement of public services to foster a sustainable economy, society, and environment; the establishment of integrated governance through citizen participation, and innovative open platforms like living labs for public-private collaboration; continuous government policy support; and the strengthening of local government capabilities. These factors collectively pave the way for the realization of smart cities that prioritize long-term prosperity and well-being.

4.2. Policy and Managerial Implications

The findings of this study offer important insights for both managerial and policy considerations. As smart cities continue to evolve, enhancing citizens' awareness and understanding of their significance becomes paramount for their sustainable growth. Therefore,

policy makers should prioritize the development and implementation of policies aimed at enhancing public awareness of smart cities, with a particular emphasis on smart public services, social, and environmental values. Additionally, policy initiatives should address regulatory improvements, encourage corporate participation, foster open interaction, and ensure robust government support to facilitate the realization of smart city. Moreover, the specific role of local governments in advancing smart city initiatives should be clearly defined and reinforced within society. These measures collectively contribute to the successful development and implementation of smart city projects.

There is a notable gap regarding the disparities between the perspectives of experts, such as researchers and practitioners, and those of smart city citizens concerning government policies and the implementation of smart cities. This underscores the need for comprehensive investigations based on in-depth interviews with key stakeholders, including researchers, practitioners involved in policy implementation, and citizens residing in smart cities. Such research endeavors can provide valuable insights into the effectiveness of government policies and the attitudes of citizens toward smart city initiatives, thus contributing to a more nuanced understanding of this rapidly evolving field. Therefore, this study employed a qualitative research approach including literature review and case studies, utilizing data gathered through in-depth interviews with researchers, practitioners, and citizens. The study focused on extracting variables deemed significant based on existing literature, case studies and in-depth interviews. This methodology allowed for a detailed exploration of key factors influencing perceptions and attitudes toward smart cities among various stakeholders. Through this approach, the study aimed to understand the perspectives of researchers, practitioners, and citizens regarding the impact and development of smart cities, the quality of life within such cities, the role of local governments in their growth, and the future prospects of smart city initiatives.

Furthermore, the study provided insights into the direction in which local governments should develop and revise smart city-related policies, such as improving efficient management and operations, enhancing collaboration with stakeholders, and refining promotion strategies. In this sense, this study is expected to complement the limitations in existing research by exploring citizen awareness of smart cities and proposing policy improvements. By considering the perspectives of researchers, practitioners, and citizens, it suggests the necessity of better policies for the growth and prospects of smart cities.

4.3. Limitation and Future Study

This paper has limitations and provides implications on future studies. This study may have regional limitations as it is based on data from researchers and practitioners involved in South Korea's smart city policies and development, as well as general citizens residing in smart cities within the country. In future research, enhancing the sample size of researchers, practitioners engaged in smart city policy and development, and general citizens residing in smart cities could offer more comprehensive and diverse data for analysis. Future studies could explore the application of structural equation modeling and examine the development of various smart city models led by different stakeholders beyond government-driven initiatives. Analyzing the response patterns of a broader range of stakeholders, including local government officials and participating companies based on the type of smart city could address the current limitation of this study and shed light on factors influencing civic awareness across different smart city models.

Furthermore, additional research is warranted to explore other factors beyond those considered in this study to assess the attitudes of citizens who have experienced smart cities, as well as to delve deeper into the development and prospects of smart cities and the role of local governments. By incorporating a broader range of variables and perspectives, future studies can provide a more comprehensive understanding of the complex dynamics shaping the evolution of smart cities and their impact on residents' lives.

Lastly, despite the extensive literature research on smart city cases overseas and their associated factors for realization of smart cities, because the data was collected from researchers, practitioners involved in South Korea's smart city policies and development, as well as citizens living in smart cities, the analysis results may be limited to South Korea. Given the differences between countries, applying the research model to different countries by expanding the sample size to include officials and other stakeholders from more smart cities abroad, may result in further studies.

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Appendix A

Interview Questionnaire

Hello, nice to meet you. I'm Maeng Joo Yeol, a doctoral student at KDI Graduate School of Policy. My current research focuses on the factors influencing citizen awareness of smart cities, the development of smart cities, and the role of local governments in their growth. Today, I'd like to discuss the current state of smart cities in Korea, the factors contributing to their growth, and the roles and prospects of local governments in this context. Before we begin, I would like to confirm if you consent to recording this interview and using it for research purposes. Your responses will be kept strictly confidential and anonymized. The aim of this interview is for academic research, and no individuals will be identified in any analysis or report involving the interview data. Your input is crucial in identifying issues related to smart city policies and developing potential solutions. With your honest opinions, we can work towards overcoming these challenges. Now, if you're ready, please introduce yourself briefly, including your name, age, and current occupation, and we can proceed with the interview

Part 1: Factors Influencing Citizen Awareness of Smart Cities

1. Do you believe that establishing smart cities is crucial in our country, given the pressing issues of urban population concentration, resource depletion, and climate change? If so, what are the reasons behind this belief?

2. Considering that citizen awareness and involvement in smart cities are not as high as anticipated, do you think there should be more promotion efforts to raise awareness? Why or why not? Additionally, do you believe the current promotional strategies are effective?

3. Are you anticipating improvements in the evaluation, perception, and preference for areas where smart city initiatives are implemented? How do you perceive the actual sentiments and feedback from residents in these areas?

4. Which factors, in your opinion, positively influence citizens' attitudes toward smart cities? What are the underlying reasons for these factors being influential?

5. In your view, which factors contribute positively to the quality of life for citizens through the implementation of smart city initiatives? Could you elaborate on why these factors are perceived to enhance quality of life?

Part 2: Factors required for smart city development

1. What factors do you believe positively influence the development of smart cities? Could you explain why you think these factors are crucial?

2. Do you foresee continued development in the realm of smart cities? If so, what factors contribute to this expectation?

Part 3: The role of local governments in fostering sustainable smart cities

1. Do you consider the creation of smart cities to be a significant responsibility of local governments? Could you elaborate on your reasoning?

2. From your perspective, which factors contribute positively to citizens' perception of the role played by local governments in the development of smart cities? What are your reasons for selecting these factors?

Part 4: Factors impacting the outlook of smart cities

1. What factors do you believe positively influence the future prospects of smart cities? Could you explain why you consider these factors to be influential?

CHAPTER 2

HOW CITIZENS PERCEIVE SMART CITY IN SOUTH KOREA: THE NECESSITY OF POLICY IMPROVEMENT

Chapter 2

How Citizens Perceive Smart City in South Korea: The Necessity of Policy Improvement

By

Jooyeol MAENG[1] Yooncheong CHO[2]

Abstract

This study aims to provide insights into policy formulation and adjustments regarding smart cities in Korea by examining citizens' perceptions of smart cities and identifying factors influencing the growth of sustainable smart cities. The study comprises five parts:

1. Understanding the definition and scope of smart cities.
2. Perceiving the impact of smart cities on society.
3. Understanding the growth of smart cities in society.
4. Perceiving the role of local government in the growth of sustainable smart cities.
5. Perceiving the prospects of smart cities.

Through factor analysis, ANOVA and multiple regression analysis of data collected through an online survey, the study identifies key factors influencing citizens' overall attitude toward smart cities. Factors such as city brand value, institutional improvement, corporate participation, and open interaction significantly impact citizens' attitudes, particularly institutional improvement affecting attitudes positively. Furthermore, the study reveals how factors like user-centered technical support, central government support, and local government support influence the growth of smart cities. It suggests that citizens perceive smart cities supported by local governments more favorably, especially when they offer user-centered technical support. Additionally, the study uncovers that factors like local government's management skill and collaboration capability affect citizens' perceptions of the role of local government in fostering

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sustainable smart cities. It emphasizes the crucial role of local governments in encouraging citizen participation through effective management and collaboration with stakeholders. Finally, the study highlights factors such as promotional strategy, public service, economic factors, social factors, and environmental factors that influence the prospects of smart cities. It suggests that promotional strategy has a significant impact on citizens' perceptions of smart city prospects, indicating the importance of strategic promotions in local government policy for smart cities. Overall, the study provides valuable policy and managerial implications for enhancing citizens' attitudes, satisfaction, and prospects regarding smart cities through appropriate policy adjustments and preparations.

Keywords: Smart City, Citizen Experience, Quality of Life, Collaboration, Technical Support, Social and Environmental Value, Sustainability, Local Government

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I. Introduction

In recent years, smart cities have garnered increasing attention from academia, industry, and numerous countries worldwide. This heightened interest can be attributed to the rapid progression of urbanization, informatization, and globalization. Smart cities are essentially complex systems that involve interconnected elements such as people, institutions, technologies, organizations, environments, and physical infrastructure (Chourabi et al., 2012). Among these elements, information and communication technology (ICT) plays a pivotal role, enabling cities to address various urban challenges such as traffic management, housing, energy efficiency, and environmental sustainability in innovative ways, ushering in a new era in urban studies and transforming how cities are managed and developed (Batty, 2013; Manville et al., 2014).

According to the United Nations Department of Economic and Social Affairs (UN DESA, 2022), over half of the global population resides in urban areas presently, with projections indicating that nearly seven out of ten individuals will be urban dwellers by 2050. As urbanization accelerates, various social challenges such as heightened energy consumption, traffic congestion, and intricate infrastructure issues are anticipated to emerge worldwide (Kim et al., 2018). Rapid and inadequately planned urban expansion is associated with numerous difficulties, including a scarcity of affordable housing, inadequate infrastructure (such as public transportation and basic services), limited open spaces, heightened air pollution levels, and increased vulnerability to climate-related disasters (UN DESA, 2022). Consequently, smart cities have emerged as a focal point in urban discussions, aiming to address urban challenges and enhance urban life in the future (Zheng et al., 2020).

The emergence of the 4th industrial revolution in the 21st century, characterized by advanced technologies like ICT, IoT (Internet of Things), Big Data, AI (Artificial Intelligence), AR (Augmented Reality), and AV (Autonomous Vehicle), has propelled the smart city concept to the forefront as a solution to various social challenges (Jo, 2020). Originating in the 1990s alongside the rise of ICT-related devices such as the internet and smartphones, the notion of smart cities gained traction as part of efforts to realize democratic ideals amidst shifting political and economic landscapes (Dameri & Rosenthal-Sabroux, 2014). The concept took root as early as 1993 in Silicon Valley, California, USA, where local stakeholders collaboratively established a smart community in response to long-term economic downturns (Lindskog, 2004). Evolving alongside technological advancements, a smart city is now defined

as a city where technology optimizes major systems like transportation, communication, and energy, leveraging finite resources for maximum efficiency (Dirk & Keeling, 2009). Moreover, from a political and social perspective, the concept has expanded to enhance ecological equity, integrity, and sustainability by fostering stronger community platforms that bridge information gaps among citizens, transcending mere technological intelligence (Nam & Prado, 2011; Deakin, 2014).

According to the European Commission (2020), smart cities are characterized by the utilization of technological solutions to enhance the management and efficiency of urban environments. This definition emphasizes the role of digital and telecommunication technologies in optimizing traditional networks and services for the benefit of residents and businesses (European Commission, 2020). It aligns with other scholarly definitions, such as those emphasizing the city's ability to optimize resources, providing efficient services through preventive maintenance and management (Hall, 2000), and fostering a sustainable urban environment using ICT while enhancing citizens' quality of life through innovation by connecting people, information, and the city (Bakici et al., 2013).

The significance and immediacy of smart cities are increasingly recognized as they bolster national competitiveness through advanced technology development and ultimately enhance societal value by elevating citizens' quality of life through improved transparency and efficiency (Jo, 2020). European cities like Amsterdam and Barcelona have garnered acclaim as successful smart cities, leveraging cutting-edge technologies to enhance connectivity among people, information, and urban infrastructure, thereby enhancing overall quality of life through innovative platforms fostering collaboration among government, businesses, and citizens (Bakici et al., 2013; Kim, 2020). In contrast to European and American cities, which often emphasize private sector involvement to enhance quality of life, Asian cities, including those in South Korea, initially prioritize smart city initiatives led by the public sector, often as national policy projects leveraging advanced ICT (Kim et al., 2018). In South Korea, several promising smart city initiatives have emerged, such as Seoul Smart City, which boosts the city's brand value by providing public services including free Wi-Fi at bus stops, Songdo Smart City, focusing on city safety through data-driven measures like public CCTV and sensor networks, and Sejong Smart City, which enhances citizens' transportation efficiency with advanced systems like AI-powered traffic lights and on-demand buses (Seong et al., 2016; Ahn et al., 2019; Jeong, 2021).

South Korea embarked on a pioneering intelligent city development initiative branded

as U-City in the mid-2000s, combining cutting-edge information and communication technology with new urban development projects, earning global recognition as a smart city leader, however, its prominence has waned in recent years due to technological advancements in latecomer countries and a gap in core technology development compared to more developed nations (Jang, 2018). Despite successful efforts to expand public infrastructure through ICT integration in new city developments, the top-down approach of central government promotion has often overlooked citizens' needs, leading to decreased satisfaction and widening disparities between areas where smart city projects were heavily promoted and those where they were not (Ministry of Land, Infrastructure and Transport, 2014). In contrast to European cities with clear vision statements and citizen-centered governance, South Korean cities must prioritize long-term sustainability by aligning smart city projects with strategic vision and goals. Addressing issues like low citizen awareness and the lack of a cohesive promotion system involving government, local authorities, private firms, and citizens is critical, with emerging policy alternatives such as living labs gaining traction among local governments (Jang, 2018; Lee & Han, 2019).

In South Korea, the lack of comprehensive policy frameworks and citizen awareness regarding smart cities has hindered their establishment and growth. Therefore, this study aims to investigate citizen perceptions of smart cities and propose strategies for improved management and public policy to foster sustainable citizen-centric smart cities. While previous research has explored theoretical concepts and case studies of smart cities, there is a scarcity of quantitative research analyzing citizen perspectives, participation, and policy considerations. Specifically, this study aims to address the following questions: i) How do citizens conceptualize and understand smart cities? ii) How do citizens perceive the impact of smart cities? This involves examining various factors such as citizen experience, government role, technological advancements, economic, social, and environmental values, city branding, public services, institutional improvements, corporate participation, and open interaction, and their influence on overall attitudes and quality of life. iii) How do citizens perceive the growth of smart cities? This entails exploring factors like user-centered technical support, government and private sector involvement, collaboration with expert and civic groups, and local government support, and their impact on smart city development. iv) How do citizens view the role of local government in smart city growth? This involves assessing factors such as management capabilities, promotional efforts, and collaboration capabilities of local governments and their influence on citizen attitudes. v) How do citizens perceive the future of

smart cities? This includes examining factors like promotional strategies, driving forces, public services, economic, social, and environmental factors, and their impact on citizens' attitudes and the future outlook of smart cities. The study aims to provide valuable managerial and policy implications for better citizen engagement and relationship management in smart city development.

II. Literature Review

2.1. Applications of Smart City

2.1.1. Citizen-Centered Approach

Amsterdam, the capital of the Netherlands, a city with a population of 800,000, has established the Energy Strategy 2040 in line with the Europe 2020 strategy, which includes reducing greenhouse gases by 20%, expanding renewable energy by 20%, and improving energy efficiency by 20%, and aims to reduce carbon dioxide emissions by 75% by 2040 based on the vision of building the best eco-friendly city in Europe (Manville et al., 2014). With this goal, the Amsterdam city government formed the ASC (Amsterdam Smart City) platform in 2009, a partnership between businesses, government, research institutes, and citizens, including the Amsterdam Economic Board, the city, energy supplier Liander, and telecommunications operator KPN, and carried out a smart city pilot project (National IT Industry Promotion Agency, 2013). To achieve these goals, approximately 200 organizations are participating in the ASC platform, and 64 projects are in progress in eight areas including Smart Mobility, Smart Living, Smart Society, Smart Areas, Smart Economy, Big & Open Data, Infrastructure, and Living Labs (Amsterdam Smart City, 2013). The Climate Streets project, which was promoted to improve the environment and save energy on major shopping streets in Amsterdam, saved energy by 10% and achieved a reduction of carbon emissions by more than 8% by replacing 90% of garbage collection vehicles with electric vehicles and installing smart meters in 80% of stores (Sauer, 2012). The main feature of the ASC project is the three-stage process of platform-testing-open, which reviews the appropriateness of projects carried out in various fields and locations and spreads them throughout the city (Amsterdam Smart City, 2013). It has the advantage of being able to develop a more suitable model by identifying problems and supplements in advance (Yoo, 2014). The ASC project utilizes institutions and infrastructure to directly help citizens and businesses within the city develop and experiment

with projects to realize an eco-friendly city, and eventually its role is not to provide technical solutions, but to create an environment for collaboration, co-creation, and partnership based on a platform among stakeholders within the city (Angelidou, 2014).

Barcelona, which has continuously transformed the city as an economic center in Europe despite the 2008 economic crisis, has maintained its leading position as a smart city through various smart city initiatives beyond being a knowledge-intensive city (Kim, 2020). Barcelona Smart City connects people, information, and other cities to create a sustainable, eco-friendly urban environment, an innovative commercial environment, and improves the quality of life by guaranteeing the direct participation of citizens (Ajuntament de Barcelona, 2014). The city also promotes the formation of various ideas through an innovative living lab and data open environment with a cluster composed of companies, universities, and research institutes related to ICT ecology and urban planning in the service development process (Komninos et al., 2013). The main core areas of the Barcelona Smart City model can be classified into smart governance, smart economy, smart life, and smart people, and the three means to achieve the goals in these areas are presented as infrastructure, information, and human capital based on cooperative relationships between citizens and businesses (Bakici et al., 2013). Barcelona Smart City has more than 33 major projects in progress, consisting of public and social services, environment, mobility, enterprise, research and innovation, communication, infrastructure, tourism, and citizen cooperation (www.barcelona.cat).

Table 1. Major Smart City Projects in Barcelona

Project Name	Main Content
Apps4Bcn Portal	Provides information necessary for city life such as arts, entertainment, sports, health, tourism, etc.
New Bus Network	Provides various traffic information for efficient movement within the city
Telecare Service	Emergency response services for the elderly, disabled, etc.
Open Data	Opening of information related to public administration, services, economy, population, region, etc.
Electric Vehicles	Reduces environmental pollution and improve energy efficiency through electric energy-based transportation
Barcelona Wi-Fi	Improving citizens' internet accessibility through Wi-Fi installation in 193 facilities and 276 streets
Smart Traffic Lights	Provides audio for the visually impaired and providing a passage for smooth emergency dispatch of fire trucks
School Route	Provides safe routes to and from school
ApparkB	Provides parking service using smartphones without using parking meters
Mobile ID	Provides a safe administrative process and administrative service use environment through electronic recognition through smartphones
Fabrication Laboratories	Provides learning programs on new scientific and technological models

OVAC	A system that provides services such as tax payment, information guidance, issuance of administrative documents, and filing of civil complaints.
mSchools	Provides secondary education programs using mobile technology
BCN Contactless	Provide information services related to the city by accessing signs with NFC and QR codes installed throughout the city through smartphones, tablets and etc.
Radars Project	Provides necessary help for the lives of the elderly through social networking with local residents, experts, volunteers, etc.
Sustainable Barcelona Map	Provides physical and social information about the city based on cooperative relationships between citizens
Bicing	Bike sharing system
Procedures Portal	Enhances government flexibility and accessibility by providing online city administrative services
Smart City Campus	As a dense area of companies, innovation centers and universities, it enhances synergies and co-creation efforts in new urban services and smart city models.
Smart Allotment	Program to promote collaborative thinking among students using new technologies
Smart Quesina	Bus information provision system using Wi-Fi and touch screen technology
Superblocks	Establishment of sustainable city strategy program through participation of the general public
Telemanaging Irrigation	Efficient water resource management system using smart devices
Vincles BCN	A digital platform to prevent social isolation among older people
City OS	A technological platform to improve citizens' lives and support urban management decision-making.
Barcelona Open Government	A government that pursues participation, transparency, and cooperation between the public sector and citizens
Sentilo	Open source code that is functional, open, interoperable, and extensible.
BUITS Plan	Urban regeneration project through temporary use of unused land
Citizen's Postbox	Smartphone application that provides accident information in real time
Barcelona Negocis	A council that discusses and diagnoses various city issues

Source: https://www.barcelona.cat

The smart city initiatives underway in Barcelona, as depicted in Table 1, exemplify a comprehensive approach to enhancing citizen quality of life across various urban domains. These projects not only deliver essential public services but also prioritize citizen engagement by involving experts in the service development process. Barcelona's Smart City initiatives represent a pioneering urban model aimed at fostering a knowledge society characterized by ongoing interaction among companies, the public sector, and citizens, thereby creating a conducive environment for networking and communication (Bakici et al., 2013; Angelidou, 2014).

2.1.2. Improving Citizen-Centered Approach

China, leading the way in smart city projects among Asian nations, has undergone swift urbanization following its shift towards reform, openness, and market-oriented economic policies since the early 1980s. China's urbanization rate, which was only about 13% in the

1950s, increased to 26% in the 1990s and reached 61% in 2019, and it is expected that about 75% of people will live in cities by 2050 (UN DESA, 2022; Qi et al., 2020). China's rapid urbanization has caused a series of urban diseases, such as housing, energy, traffic congestion, environmental pollution, contradiction between supply and demand of resources, social inequality and lack of public services, in particular, environmental problems such as consuming 70% of world's total energy and producing more than 75% of the garbage caused by rapid urbanization process are severe challenges to sustainable development (Huang et al., 2021). The challenges of disorder and disorganization in Chinese cities have spurred the adoption of smart city policies, with a significant emphasis on government-led infrastructure development driven by new technology mechanisms (Shen et al., 2018). The driving forces enabling the development of smart cities for solving urban issues and infrastructure construction in China, which announced the National New Urbanization Plan (2014–2020) in 2013, include the central government's strong and systematic policy support, publicity and promotion of ICT enterprises (Huang et al., 2021). The strategic cooperation between city governments like Nanjing, Shenyang, Chengdu, and Kunshan, supported by central government policies and financial backing, has led to the initiation of smart city construction projects, often in collaboration with companies like IBM (Chen et al., 2013). China's approach to smart city development is characterized by a top-down construction model and techno-centrism, emphasizing visible short-term effects and this strategy has involved substantial investments, with China allocating $300 billion to IT from 2011 to 2018, and the promotion of over 800 large-scale smart city projects across the country (Huang et al., 2021; Marsal-Llacuna et al., 2015).

The issues facing China's smart cities are multifaceted, with concerns raised about the lack of a clear vision or defined goals, leading to the deployment of extensive information infrastructure without achieving holistic smart city development (Nam & Pardo, 2011). This approach results in imbalanced systems across various sectors, including infrastructure, governance, economy, and environment, with particular deficiencies noted in essential areas such as healthcare services and urban equity (Shen et al., 2018). It is emphasized that technology should serve as a means to address urban challenges rather than an end in itself, so a shift towards a people-centered approach is advocated, prioritizing the alignment of technology with social needs and fostering balanced relationships between technology, innovation, society, culture, and the environment (Xu & Geng, 2019). Moreover, while many smart cities in China prioritize the establishment of smart ecological systems in their

overarching plans, in practice, insufficient attention and investment are directed towards environmental considerations, consequently, there is a pressing need for sustainable smart city development policies to rectify the imbalance between environmental conservation and urban development (Liu & Peng, 2013; Olhoff & Christensen, 2018). Additionally, the implementation of uniform smart city designs without considering the varying capacities and regional characteristics of local governments exacerbates disparities in smart city advancement across regions, which results in smaller cities, with comparatively weaker information technology infrastructures, struggling to achieve the cohesive benefits anticipated from smart city initiatives (Yao et al., 2020). Furthermore, the lack of core technologies for city information management and operations, coupled with the absence of open data and data management policies to facilitate collaborative innovation platforms among stakeholders, pose significant barriers to the development of smart cities in China (Lim et al., 2018).

Sejong City, designated as a national pilot city development project, is evolving into a smart city with a central focus on energy and transportation. Positioned as a self-sufficient urban hub, Sejong City integrates diverse functions including housing, administration, research, and industry, leveraging its proximity to key institutions such as the Government Complex, national research complexes, universities (including KAIST), the Daedeok Research Complex, and the Osong Life Science Complex (Na et al., 2020). Sejong Smart City, which aims to create a sustainable platform city using data, has been designated as a smart regulation innovation district, allowing private companies to experiment with various smart innovative technologies and services without regulatory constraints (www.sejong.go.kr.). It is planned to be created as an autonomous driving-specialized city based on smart infrastructure such as autonomous driving precision maps, 3D spatial information system, and C-ITS (public transportation, connected cars), and in the living and safety areas smart farms, fine dust monitoring, and disaster response AI systems are being promoted (Jo, 2020). In particular, Sejong Smart City has set seven major innovation elements, including mobility, education/jobs, energy/environment, safety/life, culture/shopping, governance, and healthcare, and is pursuing the implementation of the corresponding services (www.sejong.go.kr.). Table 2 shows the seven major innovation elements and corresponding projects being promoted by Sejong Smart City.

Table 2. Major Innovation Elements and Projects in Sejong Smart City

Innovation Element	Main Projects

Mobility	Personal mobility/car sharing service, autonomous driving, integrated mobility, smart parking
Education/Jobs	Smart learning space (online, offline) edutech, introduction of learning system (IB), lifelong education service
Energy/Environment	Urban crime prevention service, smart living convenience service, fine dust reduction system
Safety/Life	Opening of information related to public administration, services, economy, population, region, etc.
Culture/Shopping	Performer-audience customized linkage service, construction of variable performance culture space, smart integrated delivery service
Governance	Providing a citizen-participatory decision-making system
Healthcare	Personalized health management service, AI-based emergency medical system, smart home doctor service

Source: https://www.sejong.go.kr

Sejong City's emphasis on specialized mobility initiatives is evident in its establishment of an automated data collection system, which efficiently manages data acquired from autonomous driving and mobility activities leveraging the data for autonomous vehicle urban operations and services within digital twins, thereby enhancing the stability and satisfaction of autonomous vehicle services (Kim et al., 2023). Moreover, in the healthcare domain, Sejong City has introduced innovative measures to swiftly address citizens' health concerns akin to a large-scale hospital being achieved through a meticulously structured medical network environment, encompassing strategies for smart emergency response, smart medicine delivery, smart health management, and smart safety protocols (Choi, 2022). Regarding to governance, it aims to encourage citizen participation by systematizing platforms such as living labs so that citizens can suggest opinions on local issues and solve them directly and in the fields of education/jobs, energy/environment, safety/life, and culture/shopping, Sejong smart city is promoting various public services such as the life-long education system, fine dust reduction, smart administration, and smart delivery to improve the quality of life of citizens. (Ministry of Land, Infrastructure and Transport, 2019).

Despite Sejong City's multifaceted policy endeavors aimed at fostering a sustainable smart city, concerns persist regarding citizens' perceptions of various services and their level of participation and engagement in platforms like living labs for service development. Regarding the innovativeness of a sustainable smart city in Sejong city, Cho and Oh (2019) has emphasized the policy necessity for revitalizing a smart research park such as Kalasatama in Helsinki, Makerversity in Amsterdam, DOLL Institute in Copenhagen, and Science Park in Singapore where citizens, companies, and stakeholders can plan, experiment, and operate the city in a more innovative way while sharing ideas based on open data.

Songdo City, situated within the Incheon Free Economic Zone (IFEZ) in South Korea,

is meticulously planned and constructed to emerge as a premier international business district in Northeast Asia. Positioned as a hub for business and research, Songdo aims to establish an environmentally sustainable community by leveraging advanced information and communication technologies at a large scale (IFEZ, 2010). Initially conceived as U-City in 2003 with the objective of crafting a high-tech green city and serving as a catalyst for national growth, Songdo transitioned into a smart city project in 2017 (Jeong, 2021). It is currently undergoing enhancements to integrate new technologies into its smart city services (Incheon Free Economic Zone Authority). Table 3 outlines the key smart city services being implemented in Songdo.

Table 3. Major Smart City Services in Songdo Smart City

Main Services	Service Contents
Transportation	- A service that improves transportation convenience by providing various traffic information in real time - Intelligent traffic flow management, emergency situation management, bus arrival information, and parking guidance service - The bus information terminal provides bus arrival information in multiple languages, including Korean and English. - Monitoring bus stops through CCTV and taking actions in cases of emergency - Real-time monitoring of traffic flow information and unexpected situations using cameras and detectors
Environment	- Services providing air quality information, water quality information, environmental information, etc. - Real-time detection of fine dust, visibility, road surface icing, etc. with state -of-the-art detection sensors
Safety	- A service that acquires, monitors, and analyzes information on city security, crime prevention, incidents, and accidents in real time. - CCTVs installed throughout the city detect and take action through intelligent video surveillance in abnormal situations such as wandering around. - CCTV installed at major intersections recognizes the number of wanted vehicles and takes action.
Disaster	- A service that prevents disasters by monitoring major areas within the city And creates a safe city life through a rapid response system linked to the police and fire departments. - In the event of a disaster, citizens are advised to evacuate through the web, electronic signs, speakers, etc.
Facility	- Monitors the status of on-site installed facilities (traffic cameras, atmospheric information sensors, crime prevention CCTV, etc.) to provide a basis for quick action in the event of a failure. - The smart city operation center comprehensively manages various facilities based on information collected through RFID, sensors, etc.

Source: Son, (2018); https://www.ifez.go.kr

In Songdo smart city, Cisco showcases their Smart + Connected Communities program fully by deploying a network connecting all components of the city, including residences,

offices and schools, so residents can control some functions of their homes remotely and everyone is able to interact anywhere through Cisco's telepresence system (CISCO, 2013). The evaluation of Songdo smart city underscores how it exemplifies the utilization of technological systems to redefine citizens as valued participants primed for success in the global knowledge economy, thereby shedding light on the exclusionary facets inherent in the concept of a smart city (Benedikt, 2016). Songdo is regarded as a pivotal instance where knowledge assumes a position of power in facilitating the implementation of the new urban agenda, thereby validating the smart city as a logical technological solution for urbanization in the 21st century (Kuecker & Hartley, 2020).

Indeed, despite the inauguration of the initial phase of Songdo Smart City in 2009, the city's development has encountered sluggish progress vis-à-vis the original blueprint, primarily attributed to a myriad of challenges encompassing budgetary constraints, inadequate governmental support, bureaucratic hurdles, regulatory complexities, opposition from stakeholders, and the inability to entice foreign investment (Shwayri, 2013). Addressing these issues is imperative for the establishment of a sustainable smart city in Songdo.

2.2. Smart City and Public Policy

2.2.1. Necessity of Policy Preparation for Smart City

Indeed, as the concept of smart cities garners increasing attention and emerges as a focal point for policy agendas worldwide, many city administrations, irrespective of their developmental context, perceive smart urban technologies as potential solutions to address a spectrum of present and future challenges, spanning economic, societal, and environmental realms (Yigitcanlar, 2017). Nevertheless, the strategic planning for smart city development often remains nebulous, largely due to conflicting interests among stakeholders, including local governments, research institutions, citizens, and technology companies, coupled with a prevailing notion that innovative technologies alone can catalyze smart urban transformation (Angelidou, 2014). To effectively engage the private sector and citizens and cultivate an innovation ecosystem, urban policies akin to Barcelona's smart city approach are indispensable, which foster a conducive environment for public-private partnerships to thrive by furnishing the requisite legal framework and conducive space for collaborative ventures (Wareham et al., 2012). Indeed, as exemplified by cities like Amsterdam, New York, and Barcelona, which

embarked on their smart city endeavors by identifying and addressing pressing needs in specific domains such as open data, energy, digital society, environment, and energy, it is imperative for smart city planning to embrace selectivity, synergies, and prioritization and these principles facilitate the delineation of roles for various stakeholders including citizens, private companies, research institutes, and local governments, thereby ensuring effective collaboration and concerted efforts towards achieving smart city goals (Angelidou, 2014).

Regarding the outcomes of sustainable smart cities, Ahvenniemi et al. (2017) argue that there is little empirical evidence that smart cities have contributed to the city's sustainability agenda, so the role of smart city technologies should be in enabling sustainable development of cities, not the end in itself. For example, according to Yigitcanlar & Kamruzzaman (2018), the carbon dioxide emissions results of 15 cities with different smart city levels in the UK reveal that the link between city smartness and carbon dioxide emissions is not linear, and the impact of city smartness on carbon dioxide emissions do not change over time. This underscores the necessity for research to assess whether current smart cities, driven by their individual goals, are indeed contributing positively to urban sustainability. Moreover, it highlights the importance of implementing policies that ensure smart city strategies are aligned with achieving tangible and sustainable outcomes for urban environments.

Technological challenges stand out as significant obstacles in smart city implementation, for instance, smart city technologies, typically developed by various vendors and organizations, often result in fragmentation, complexity, and compatibility issues (Khan et al., 2020). This hampers the seamless integration of different technologies, leading to increased costs and implementation delays (Attaran et al., 2022). Additionally, financial and legal challenges pose substantial barriers to smart city initiatives and smart city projects are often costly, surpassing available budgets and requiring long-term investments (Ahad et al., 2020). To overcome these challenges, innovative financing models need to be developed, and legal issues such as data privacy and ownership must be addressed with the guidance of legal experts (Lnenicka et al., 2022). Social and cultural challenges present additional obstacles to smart city implementation. Resistance to change is a prevalent issue encountered during smart city projects, as citizens may express concerns regarding the collection, storage, and utilization of their data due to privacy and security apprehensions (Dashkevych & Portnov, 2022). Consequently, the adoption of new technologies and behavioral changes may be delayed, leading to postponements in smart city implementation, so building public trust and garnering support for smart city initiatives become crucial endeavors to overcome these challenges (Gharaibeh et al., 2017).

Therefore, to cultivate a sustainable smart city, it is imperative to establish robust governance structures that promote collaboration, transparency, accountability, and engagement among all stakeholders. Clear legal frameworks for data openness and sharing must be put in place, alongside innovative financing models to address technical, financial, legal, social, and cultural challenges. Additionally, a strategic approach is necessary, involving research into the creation of user-centric practical services in smart cities, grounded in standardization and interoperability principles.

2.2.2. Policy Issues for Smart City in South Korea

In contrast to smart cities in overseas countries, which are predominantly driven by the private sector and foster collaboration among citizens, private companies, and experts to create services, the key characteristic of smart city development in Korea is its government-led management and operation across various aspects of city life and infrastructure, encompassing administration, transportation, and more (Cho, 2017). However, this structure in Korea often leads to a cycle where integrated infrastructure for city management exists, yet citizen and private sector participation remains low, hindering the realization of innovative ideas in service provision. Furthermore, there is a recognized inadequacy in the degree of integration among various public data sets, such as those related to traffic, crime prevention, disaster management, and the environment, within the integrated platform, so there is a pressing need to expand and enhance this integration, alongside the establishment of policies aimed at creating innovation space platforms, including living labs, to facilitate private and citizen-led innovation based on open data (Lee & Han, 2019).

In the context of building a smart city, unlike conventional new city projects, it represents an urban construction endeavor underpinned by advanced technology and collaborative efforts among all stakeholders. Therefore, it is imperative for the government to comprehend how the extent and manner of governmental regulation will influence the realization and success of smart cities (Jo, 2020). Despite the South Korean government's ongoing promotion of smart city initiatives since the mid-2000s, there remains a lack of a systematic plan to assess and validate the outcomes of these projects (KRIHS, 2017).

Therefore, reflecting on past shortcomings and leveraging existing successes, there is a pressing need for policy support aimed at establishing themed smart city complexes tailored to local characteristics, which would empower each local government to identify and implement smart city projects aligned with regional attributes (Jang, 2018). Building upon this perspective,

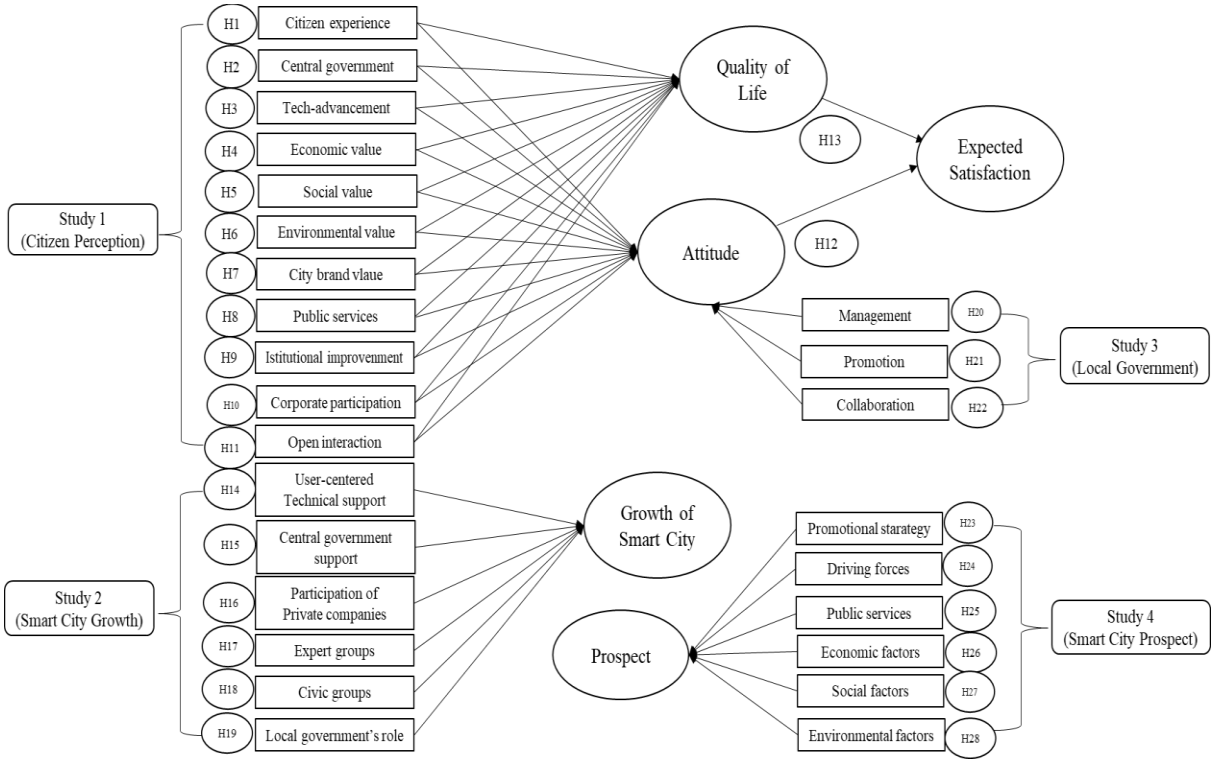
Jo (2020) highlights that certain local governments, such as Incheon, Sejong, and Hwaseong, which have spearheaded South Korea's flagship smart city initiatives, have primarily adopted transportation, crime prevention, and traffic services based on LH Corporation's projects which have a standardized infrastructure was established, neglecting the distinctiveness of each locality, consequently, this homogenization has led to diminished citizen satisfaction with services and inefficiencies in addressing urban challenges.

The complexity arising from the involvement of multiple ministries and overlapping regulations poses a significant challenge in the development of smart city services. Despite the government's announcement of plans to mitigate smart city regulations through a regulatory sandbox, there remains a notable absence of policy alternatives geared towards crafting a regional, innovative regulatory sandbox system that accommodates the social and cultural landscape, so rather than relying solely on declarative laws, there is a need for continuous management and operation of the regulatory sandbox system (Choi & Lee, 2022). This situation underscores a recurring theme in South Korea, where the government emphasizes the development of more innovative services accessible to citizens and businesses through enhancements in laws and systems, including regulatory reform. However, the interwoven responsibilities and regulations across various ministries present a formidable obstacle akin to a tangled thread. As a result, establishing a control tower to oversee smart city endeavors and implementing an effective regulatory sandbox remains challenging.

III. Hypotheses Development

The hypotheses of this study are divided into four parts. Study 1 investigates the influence of various variables on citizens' overall attitudes toward smart cities and their quality of life. It also explores how these attitudes and quality of life impact citizens' expected satisfaction with smart cities. Study 2 analyzes the impact of six variables on citizens' perceptions of the growth of smart cities. Study 3 assesses how the proposed variables concerning the role of local government in smart city growth affect citizens' overall attitudes. Finally, Study 4 examines the influence of six proposed factors on the prospects of smart cities.

Figure 1. The Logic Model of Hypothesized Variables in Studies 1, 2, 3, & 4



Note: This figure is an integration of the multiple regressions that are modeled and analyzed in this study.

3.1. Study 1: How Do Citizens Perceive the Impact of Smart Cities in the Society?

The aim of this study is to investigate the driving forces behind the development of smart cities and their impact on citizens' overall attitudes toward smart cities and quality of life. The proposed factors to be explored include citizen experience, the role of the central government, technological advancement, economic value, social value, environmental value, city brand value, public service, institutional improvement, corporate participation, and open interaction in smart city development. Through hypothesis testing, the study will analyze which of these factors related to smart cities influence citizens' overall attitudes toward smart cities and their quality of life. Additionally, the study aims to gather opinions on policy promotion, which will help derive policy implications and increase the intention of residents to live in smart cities.

Quality of life in smart cities is considered as an indispensable factor in the initiatives and vitalization of smart cities, as emphasized in a lot of definitions and policies of living labs in various cities. As a city becomes smart when aspects such as human-social capital and ICT infrastructure support economic growth and a better quality of life, so it is considered that the

key elements of smart city development include well-being and quality of life (Macke et al., 2018). Improvements in public service delivery, addressing concerns like traffic congestion, pollution, and social safety, directly translate into enhancements in citizens' quality of life—a central tenet of smart city development (Wu et al., 2018). Governments, thus, prioritize initiatives aimed at improving public services, expanding inadequate infrastructure, and fostering a sustainable urban environment in smart cities, leveraging advanced technologies to uplift the quality of life (Chintagunta & Narayanaswami, 2019). Ultimately, enhancing quality of life entails bolstering livability, material and physical well-being, and delivering tangible benefits to citizens (Anthopoulos, 2017; Welde, 2012).

3.1.1. Effects of Citizen Experience on Overall Attitude and Quality of Life

As evident in numerous smart city case studies, citizen participation, facilitated through experiential engagement, emerges as a pivotal factor shaping citizen governance and augmenting their quality of life—a cornerstone in the functioning and advancement of smart cities. Margerum (2002) contends that effective planning and implementation of urban policies, crucial for sustainable urban development, necessitate citizen involvement as these policies should resonate with citizens' experiences. Much like how the proliferation of ICT has spurred societal and behavioral transformations across various domains, the broadening of citizen participation in a grassroots manner is viewed as a highly impactful change in the trajectory of smart city development. In other words, the question is how to materialize various services within a smart city that citizens can directly experience as differentiated smart city services.

In the context of prioritizing participation that honors citizen experience in the smart city development process, Deakin (2013) underscores that the hallmark of smart cities lies in the shift from government-driven policy decision-making to citizen-driven policy decision-making rooted in firsthand experiences. This shift is perceived as one of the most influential factors in fostering sustainable initiatives and dynamics within smart cities. Therefore, this study hypothesized the effects of citizen experience on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H1a: Perceived citizen experience in smart cities affects citizens' overall attitude.

H1b: Perceived citizen experience in smart cities affects quality of life.

3.1.2. Effects of Central Government's Role on Overall Attitude and Quality of Life

As the competition among nations for smart city development intensifies due to its recognized social and economic benefits, the role and policy stance of the central government have become increasingly crucial for ensuring the sustainability of smart cities. Numerous studies have highlighted key challenges in smart city initiatives, including budgetary constraints, inadequate planning, and difficulties in attracting residents and investment (Shwayri, 2013). Moreover, the complexity of orchestrating the diverse ecosystem comprising people, institutions, and stakeholders necessitates concerted efforts and systematic strategies to enhance existing infrastructure into smarter systems (Bélissent, 2010).

Central to addressing these challenges is the capacity of the central government, which plays a pivotal role in tackling issues such as budget shortfalls, implementing technological infrastructure, and coordinating stakeholders, including citizens, all of which have been identified as major obstacles in smart city development (Tan & Taeihagh, 2020). Myeong et al. (2018) observe that the government's endeavors to establish smart cities are largely influenced by the central government's intentions and policy agendas, which consider the political will of local governments. Consequently, despite the emphasis on bottom-up approaches involving the private sector and citizens, the significance of the central government's role and determination in securing funding and establishing an integrated governance framework remains paramount in smart city development. In other words, considering that the government's role is essential because smart cities are a national policy project, it is quite meaningful to examine how citizens perceive the government's role and how it affects their quality of life. Therefore, this study hypothesized the effects of central government's role on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H2a: Perceived central government's role in smart cities affects citizens' overall attitude.

H2b: Perceived central government's role in smart cities affects quality of life.

3.1.3. Effects of Technological Advancement on Overall Attitude and Quality of Life

Smart cities, rooted in cutting-edge technologies such as ICT, big data, IoT, and AI, have placed significant emphasis on technological advancement as a competitive advantage and essential component. The evolution of new technologies has unlocked possibilities previously unimaginable in urban settings. Particularly, the continuous exploration of smart technologies, including digital services and internet networks, has led to various innovations and services, with independent developments seamlessly interconnected (Taylor & While, 2017). Consequently, addressing urban challenges using ICT has emerged as a primary objective in

smart city development, with digital technology advancements significantly impacting various city sectors, and the proliferation of ICT systems has generated vast amounts of data, becoming a cornerstone of smart city evolution (Toporkoff, 2012). Considering that the infrastructure used in U-city, which was celebrated for its cutting-edge ICT technology just 10 years ago, gradually disappeared due to the emergence of more innovative technologies, the growth of sustainable smart cities, which also serve as testing grounds for advanced technologies, raises the question of how to keep pace with technological progress.

Consensus among studies underscores the pivotal role of cutting-edge technological applications as key components of smart cities, facilitating more efficient systems through precise and rapid analysis of diverse datasets (Glasmeier & Christopherson, 2015; Allam & Dhunny, 2019). Therefore, this study hypothesized the effects of technological advancement on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H3a: Perceived technological advancement in smart cities affects citizens' overall attitude.

H3b: Perceived technological advancement in smart cities affects quality of life.

3.1.4. Effects of Economic Value on Overall Attitude and Quality of Life

The economic value propagated by smart cities holds significant importance, as it generates positive effects on countries, private companies, societies, and citizens alike. Smart city development is often associated with fostering economic growth and enhancing efficiency, with economic development characterized by job creation and the emergence of new business opportunities (Capdevila & Zarlenga, 2015). Specifically, the economic impact of smart cities extends to nurturing creative industries (Kraus et al., 2015), transitioning towards a service-oriented economy (Ménascé et al., 2017), and bolstering competitiveness in the global market (Dameri et al., 2014).

These distinct economic outcomes contribute significantly to local economic development, making smart city policies a crucial consideration for local government initiatives aimed at fostering economic growth. In other words, the realization of a smart city is often considered to have significant positive economic benefits, impacting not only individual lives but also local and national economies. Therefore, this study hypothesized the effects of economic value on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H4a: Perceived economic value in smart cities affects citizens' overall attitude.

H4b: Perceived economic value in smart cities affects quality of life.

3.1.5. Effects of Social Value on Overall Attitude and Quality of Life

Smart cities, at their core, aim to establish a connected society through the utilization of open data, providing a platform that fosters social interaction and facilitates essential information sharing among citizens. Despite concerns such as privacy infringement and data security, smart cities have been recognized for their role in creating an open society. They encourage citizen participation, allowing individuals to freely express their needs and exchange opinions (Navarro et al., 2017). According to Mora and Bolici (2016), smart cities leverage ICT to address city-specific challenges while promoting sustainability within the community, underscoring the ultimate goal of technology in ensuring societal sustainability. Singh et al. (2022) assert that a sustainable smart city utilizes ICT to enhance quality of life and operational efficiency while meeting the economic, social, and environmental needs of present and future generations. Sajhau (2017) emphasizes that social development fostered by smart cities contributes to the creation of an equitable and just society for all citizens. In response to the negative social issues that arise from increasing individualism and stratification, the realization of a smart city embodies the social values of community spirit and cooperation, which can foster a sustainable community against global challenges such as climate change and economic crisis. Indeed, smart cities facilitate the development of sustainable communities through active social interaction among residents, often facilitated by living lab platforms such as the Seongdaegol energy self-reliant village, which leads to tailored urban regeneration efforts. Therefore, this study hypothesized the effects of social value on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H5a: Perceived social value in smart cities affects citizens' overall attitude.

H5b: Perceived social value in smart cities affects quality of life.

3.1.6. Effects of Environmental Value on Overall Attitude and Quality of Life

Smart city initiatives aimed at fostering a sustainable environment in response to global environmental challenges, such as climate change, are evident in the policies of various smart cities, underscoring the importance of environmental values for sustainable urban development. According to Ullah et al. (2020), smart cities seek to enhance citizens' economic well-being and their ability to effectively utilize modern ICT, with a particular emphasis on maintaining a green environment amid increasing urbanization and energy consumption. In terms of

environmental sustainability, Snow et al. (2016) emphasize the importance of environmental protection, which involves reducing CO2 emissions and energy consumption. Amsterdam, exemplifying many European cities, has developed the 2040 Smart City Strategy, which includes an energy strategy focused on reducing greenhouse gases, expanding renewable energy sources, and enhancing energy efficiency, with the overarching goal of becoming an eco-friendly city (Manville et al., 2014). Similarly, China recognizes the challenges posed by rapid urbanization and industrialization, such as severe resource depletion and environmental pollution, and has prioritized the creation of a sustainable environment as a critical national agenda (Huang et al., 2021).

It is evident that the inception of smart cities was driven by the imperative to address the pressing need for a sustainable environment amidst the global crises of climate change and resource depletion, transcending geographical boundaries. The success or failure of environmental conservation efforts within urban environments is arguably the most significant aspect in evaluating the sustainability of smart cities. In other words, the urban value of preserving and creating a sustainable environment, distinct from traditional urban development, is becoming the primary initiative and ultimate goal of smart city realization. Therefore, this study hypothesized the effects of environmental value on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H6a: Perceived environmental value in smart cities affects citizens' overall attitude.

H6b: Perceived environmental value in smart cities affects quality of life.

3.1.7. Effects of City Brand Value on Overall Attitude and Quality of Life

Cities such as Barcelona, Amsterdam, Singapore, and Seoul have not only spearheaded smart city initiatives but have also garnered international acclaim, serving as benchmarks for cities worldwide and enhancing their global competitiveness as city brands. Barcelona, for example, has not only prioritized building a sustainable, eco-friendly urban environment and fostering a competitive and innovative commercial landscape but has also embraced cutting-edge technologies to create a smart city that enhances the quality of life (Bakici et al., 2013). Despite concerns regarding privacy and information security, Barcelona has fostered an innovation ecosystem that fosters collaboration among companies, citizens, and universities while enhancing government transparency through open data initiatives (Kim, 2020). Renowned for its commitment to carbon neutrality, Barcelona stands as a successful model of a smart city that harmonizes industry and the environment, attracting major global IT firms like

Google, Cisco, and Apple due to its innovative infrastructure. Barcelona's transformation into a smart city has significantly bolstered its city brand, making it an attractive destination for residents and a desirable location for businesses. The resulting economic benefits stemming from the enhancement of the city's brand are anticipated to be substantial. Although it has broad implications, the realization of a smart city can be quite attractive because a city can become a brand. Through this brand value, it can bring not only economic benefits but also high social and environmental status in the international community. Therefore, this study hypothesized the effects of city brand value on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H7a: Perceived city brand value in smart cities affects citizens' overall attitude.

H7b: Perceived city brand value in smart cities affects quality of life.

3.1.8. Effects of Public Service on Overall Attitude and Quality of Life

Public services play a pivotal role in assessing the level of a smart city and the societal goals it aims to achieve. These services serve as a direct reflection of the quality of life experienced by citizens within the city. Smart cities are gaining attention because they leverage technology to address public issues that directly impact residents' lives within a cohesive community framework. A primary objective of smart cities is to enhance residents' quality of life by refining public services and bridging service gaps in areas such as healthcare, education, and childcare (Go et al., 2019). For instance, Barcelona's smart city initiatives involve the development and delivery of diverse public services through an innovative living lab cluster composed of companies, universities, and research institutes, leveraging open data and an ICT ecosystem (Komninos et al., 2013). Barcelona is currently advancing over 33 major projects spanning various sectors including public and social services, environment, mobility, enterprise, research and innovation, communication, infrastructure, tourism, and citizen collaboration, all geared towards enhancing public service development within smart cities (Ajuntament de Barcelona, 2014). In other words, when a smart city develops and provides public services that are exceptionally convenient and safe, exceeding citizens' expectations, it fosters the perception among citizens that it truly embodies the essence of a smart city. Given that smart cities prioritize improving the quality of life through accessible public services, citizens' attitudes and satisfaction with these services are expected to significantly influence their perception of the impact of smart cities. Therefore, this study hypothesized the effects of public service on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H8a: Perceived public service in smart cities affects citizens' overall attitude.
H8b: Perceived public service in smart cities affects quality of life.

3.1.9. Effects of Institutional Improvement on Overall Attitude and Quality of Life

Developing a smart city poses significant challenges due to the intricate interplay of laws, systems, and stakeholders involved in urban and technological domains. However, successful smart city models like those seen in Amsterdam and Barcelona have demonstrated innovative approaches through institutional enhancements, including various regulatory innovations. Nam and Pardo (2011) advocate for smart cities to prioritize the coordination and enhancement of both public and private institutions, leveraging IT infrastructure to foster inclusivity across diverse demographics within the city. Despite strong promotion by central governments through innovative policies, conflicts with local government regulations often arise (Myeong et al., 2018). Therefore, it's crucial to carefully navigate the legal and regulatory landscape to understand how local government regulations influence smart city promotion and development (Jo, 2020). By exploring the legal intricacies involved in smart city construction, cities can better adapt and settle quickly, especially when revising or reorganizing existing legal frameworks and collaborating with local governments (Myeong et al., 2018). When observing numerous companies involved in city planning, construction, technology development, and application, as well as the public sector, expressing grievances about the regulatory barriers within the current system, recognizing the importance of revising laws and regulations alongside technological advancements is imperative for achieving stability in smart city development. Therefore, this study hypothesized the effects of institutional improvement on overall attitude and quality of life. Thus, the following hypotheses are proposed:
H9a: Perceived institutional improvement in smart cities affects citizens' overall attitude.
H9b: Perceived institutional improvement in smart cities affects quality of life.

3.1.10. Effects of Corporate Participation on Overall Attitude and Quality of Life

Corporate participation is recognized as a crucial element in the construction and operation of smart cities, as evidenced by successful initiatives in cities like Barcelona, Amsterdam, and Singapore worldwide. Given that smart cities rely on robust infrastructure and advanced technologies such as ICT, IoT, and AI, the involvement of both private and public corporations is essential in their development and service provision (Choi et al., 2020). For

instance, Songdo smart city in South Korea, initially spearheaded by government initiatives, saw significant advancement and safety enhancements through the involvement of main developers like Gale International, Posco, and Morgan Stanley Real Estate, which leveraged technologies like CISCO's smart technology-connected community program to create a seamlessly connected environment encompassing residents, offices, and schools (Angelidou, 2014). In contemporary trends, the distinction between public and private entities in infrastructure and service provision is increasingly blurred, underscoring the growing importance of corporate entities in enhancing the quality of life in sustainable smart cities. In other words, similar to existing urban development, the active involvement of various domestic and foreign companies with advanced technologies has significantly influenced the realization of smart cities and led their growth. Therefore, this study hypothesized the effects of corporate participation on overall attitude and quality of life. Thus, the following hypotheses are proposed:

H10a: Perceived corporate participation in smart cities affects citizens' overall attitude.

H10b: Perceived corporate participation in smart cities affects quality of life.

3.1.11. Effects of Open Interaction on Overall Attitude and Quality of Life

The creation of a collaborative open platform for interaction among governments, citizens, private companies, expert groups, and civic groups is considered a crucial driving force for smart city development, especially as smart cities rely on advanced technologies and diverse stakeholder participation. The emergence of the Fourth Industrial Revolution has transformed the approach to addressing complex urban issues, shifting away from the traditional top-down government-led approach. Instead, open interaction platforms within smart cities adopt a decentralized approach to innovation, recognizing that knowledge and expertise are distributed across various sectors in society (Jaewon, 2017). As smart cities evolve, the roles of stakeholders become increasingly important, and the successful implementation of smart city projects relies on stakeholder integration and close collaboration through open innovation, ultimately leading to mutually beneficial outcomes (Myeong et al., 2018). Examples from smart cities like Amsterdam and Barcelona demonstrate the importance of platforms such as living labs as open interaction. These platforms bring together the public sector, companies, experts, politicians, and citizens to collectively identify and address social and economic issues through open and free discussions. They are regarded as essential elements for the development of future smart cities. Therefore, this study hypothesized the effects of open interaction on overall attitude and quality of life. Thus, the following hypotheses are

proposed:

H11a: Perceived open interaction in smart cities affects citizens' overall attitude.

H11b: Perceived open interaction in smart cities affects quality of life.

3.1.12. Effects of Overall Attitude and Quality of Life on Expected Satisfaction

Ajzen and Fishbein (2000) explored attitudes and the attitude-behavior relation and addressed that people's attitudes follow spontaneously and consistently from beliefs accessible in memory and then guide corresponding behavior. By examining value model of attitude and in the theory of planned behavior, Ajzen and Fishbein (2000) also highlighted that the number and types of beliefs that are accessible vary with motivation and ability to process attitude relevant information and with the context. This study hypothesized the effects of overall attitude and quality of life on expected satisfaction toward smart cities. Thus, the following hypotheses are proposed:

H12: Perceived overall attitude affects citizens' expected satisfaction.

H13: Perceived quality of life affects citizens' expected satisfaction.

3.2. Study 2: How Do Citizens Perceive the Growth of Smart Cities?

The purpose of this study is to investigate the factors that promote the growth of smart cities and how these factors impact their development. The suggested factors include user-centered technical support, support from the central government, increased participation of private companies, collaboration with expert groups, involvement of civic groups such as NGOs, and support from local governments for smart city initiatives. Hypothesis testing will analyze the influence of these factors on the growth of smart cities.

Regarding the growth of smart cities, 'growth' generally refers to an increase or expansion in size, volume, or scope over time, which are measurable and often the result of strategic actions (Reserve Bank of Australia, n.d.). More specifically, the growth of smart cities has implications in technological, economic, social, and sustainable aspects. Regarding technological growth, Kramers et al. (2014) emphasized that ICT solutions can lead to reduced energy consumption in cities, highlighting the role of technological advancements in smart city development. The economic growth of smart cities ultimately depends on detailing how the integration of smart technologies can lead to economic growth and increased urban competitiveness (Caragliu et al., 2011). It is argued that the social growth of smart cities

ultimately lies in how smart city governance can enhance social outcomes, improving public services and citizen engagement through the use of smart technologies (Meijer & Bolívar, 2016). Regarding sustainable growth, Bibri and Krogstie (2017) emphasize the importance of sustainability in the development of smart cities, discussing various strategies and technologies, including revenue growth rate increase, market share expansion, and more active citizen engagement contributing to creating sustainable urban environments.

3.2.1. Effects of User-Centered Technical Support on the Growth of Smart Cities

In the operation and management of smart cities, technical support utilizing various cutting-edge technologies such as ICT, AV, VR, Big Data, and Metaverse is considered to significantly influence citizens' overall attitudes toward smart cities by facilitating easier access to smart city services. In fact, cities with low internet penetration among households or lack of access to digital infrastructure face significant limitations in smart city development (Praharaj, 2017). Therefore, user-centered ICT technology support is essential so that more citizens can easily participate, which is the basis for smart city development. For example, Coventry City's CovJam, an online venture platform based on IBM's IT technology, enabled citizens to provide innovative ideas more conveniently (Burton, 2013), and Seoul City's Metaverse Seoul, which implements digital administrative services, is also taking the smart city to the next level by enabling the participation of more citizens (de Almeida, G. G. F, 2023). This user-centered technical support not only enhances citizen engagement, a key factor in smart city development, but also contributes to the development of a smart city with improved public services that reflect the opinions and needs of its citizens. The growth of smart cities implies both economic and social advancements, including active citizen engagement. Therefore, it is crucial for the development of smart cities to have user-centered technical support for public services. This focus can be considered a key element in their growth. Therefore, this study hypothesized the effects of user-centered technical support on the growth of smart cities. Thus, the following hypotheses are proposed:

H14: Perceived user-centered technical support for smart cities affects the growth of smart cities.

3.2.2. Effects of Central Government Support on the Growth of Smart Cities

Examining successful smart city cases reveals that continuous administrative and

financial support from the government is a key factor, which is believed to significantly influence overall attitudes and satisfaction with smart cities. As highlighted previously, the central government plays a crucial role in providing policy support, including securing ongoing financial resources, enacting legislation for the adoption of advanced technologies, maintaining collaboration with local governments, and establishing innovation platforms that facilitate citizen and stakeholder participation. These tasks are typically beyond the capacity of the private sector to undertake independently. Considering that world-class smart cities like Barcelona, Amsterdam, and London began with strong policy initiatives from their central governments and have continued to develop due to ongoing governmental support and management, it is expected that the central government's influence on the growth of smart cities will be significant. Therefore, the central government's policy support is indispensable in the creation and advancement of smart cities. Therefore, this study hypothesized the effects of central government support on the growth of smart cities. Thus, the following hypotheses are proposed:

H15: Perceived central government support for smart cities affects the growth of smart cities.

3.2.3. Effects of Expanding Participation of Private Companies on the Growth of Smart Cities

In cities worldwide, smart cities serve as significant test beds, and the increased involvement of diverse companies is anticipated to greatly impact attitudes toward smart city growth. For instance, Amsterdam's smart city initiative, aimed at achieving sustainable energy consumption to address climate change, necessitated partnerships with private entities such as CISCO and IBM to develop public services related to living, working, mobility, and the environment (Amsterdam Smart City, 2013). Therefore, the expansion of private companies' participation is expected to substantially contribute to smart city growth. Successful smart cities like Amsterdam and Barcelona in Europe are spearheading projects to deliver various public services through innovation platforms that welcome participation from any company, facilitated by open data and a regulation-free test bed environment (Bakici et al., 2013; Kim, 2020). Many global ICT companies are investing significantly in these cities to advance technology and reap profits, and these attributes are deemed critical for building sustainable smart cities, prompting numerous cities to adopt them as benchmarks. In the same context, since advanced ICT technologies significantly impact the development of smart cities, the extent to which companies possessing these technologies participate in smart city initiatives

has a significant stake in their growth. The growth of smart cities is more likely as the participation of these companies expands. Therefore, this study hypothesized the effects of expanding participation of private company on the growth of smart cities. Thus, the following hypotheses are proposed:

H16: Perceived expanding participation of private companies for smart cities affects the growth of smart cities.

3.2.4. Effects of Association with Expert Groups on the Growth of Smart Cities

Incorporating government policies and diverse citizen perspectives into smart city development, the engagement of expert groups is deemed essential for fostering collaborative governance and driving smart city growth. Expert groups play a pivotal role in generating more rational and efficient alternatives or feedback by reflecting on government policies and considering the diverse opinions of citizens. Throughout the implementation of smart city initiatives, citizens must understand the benefits associated with various smart city tools and be empowered to provide feedback to the government for refining these tools (Joia & Kuhl, 2019). Collaborative governance, as a citizen-centric process, involves three primary actors: governments, citizens, and researchers, working together to realize smart city objectives (Macke et al., 2018). Given the social diversity and complexity inherent in smart city development, it is assumed that the involvement of expert groups in various fields will help mediate social conflicts and advance without deviating from a more objective direction, thus fostering a mutually beneficial and equitable smart city community. This participatory approach underscores the interaction between policy, community, and research in making decisions aimed at enhancing citizens' quality of life. Therefore, this study hypothesized the effects of association with expert groups on the growth of smart cities. Thus, the following hypotheses are proposed:

H17: Perceived association with expert groups for smart cities affects the growth of smart cities.

3.2.5. Effects of Participation of Civic Groups the Growth of Smart Cities

Incorporating government policies and the diverse perspectives of citizens into smart city development, the involvement of civic groups emerges as a significant factor that helps maintain a balance between governmental entities and citizens in policy governance. Civic groups, comprising local residents and other stakeholders, play a crucial role in raising social

and environmental concerns within the city. They contribute to the development of policy initiatives for smart cities by organizing local discussions and advocating for citizen-centric projects (Seong et al., 2016). Through their engagement in the policymaking process, civic groups enhance the quality of life for citizens by representing the interests of various demographic groups within smart cities and refining their viewpoints more precisely. As evidenced by the development and growth of various smart cities, it remains true that the role of nonpartisan civic groups in advocating for citizens' needs and public opinion holds significant validity. Therefore, this study hypothesized the effects of participation of civic groups on the growth of smart cities. Thus, the following hypotheses are proposed:

H18: Perceived participation of civic groups for smart cities affects the growth of smart cities.

3.2.6. Effects of Local Government Support on the Growth of Smart Cities

In the context of smart city growth, local governments play a crucial role as policy implementers, making their support essential for shaping attitudes toward smart city development. Local governments are tasked with identifying urban challenges within their regions, drawing on citizen input to specify and deliver public services tailored to the needs of the community. To accomplish this, local authorities must have a deep understanding of the local socio-economic landscape and foster collaboration among stakeholders involved in smart city initiatives. This includes encouraging participation from citizens, businesses, researchers, and civic groups in innovative platforms like living labs, which serve as testing grounds for new ideas and solutions. By actively engaging these stakeholders, local governments can drive forward smart city growth in a manner that reflects the unique characteristics and priorities of their communities. In summary, the development of smart cities hinges on the cooperation and coordination between local and central governments, fostering citizen participation, expanding the involvement of key ICT companies, revising pertinent laws, and effectively managing city operations. The subjective role inevitably assigned to local governments is presumed to wield significant influence on the growth of smart cities. Therefore, this study hypothesized the effects of local government support on the growth of smart cities. Thus, the following hypotheses are proposed:

H19: Perceived local government support for smart cities affects the growth of smart cities.

3.3. Study 3: How Do Citizens Perceive the Role of Local Government for the Growth of Sustainable Smart Cities?

3.3.1 Effects of the Factors of Local Government on Citizens' Overall Attitude toward Local Government for the Growth of Sustainable Smart Cities

In today's landscape, citizens' awareness and the global competitiveness of smart cities are recognized as positive socio-economic factors, prompting cities worldwide to undertake various initiatives to promote and support smart city development while prioritizing citizen participation. Local governments, in particular, are dedicated to enhancing management practices through policy support and fostering connections between smart cities and their citizens and stakeholders, often leveraging innovative platforms like living labs.

Irrespective of a city's economic and social context, it is imperative for local governments embarking on smart city initiatives to be responsive to the needs and demands of their citizens in order to address urban challenges effectively (Fung, 2015). For example, New York City has pursued a tailored digital strategy aimed at improving access to digital public services, informed by extensive research involving residents, city employees, and technologists (Angelidou, 2014). These efforts have culminated in a comprehensive plan to unlock New York City's digital potential and foster an open government environment, providing valuable insights and ideas to stakeholders in both the public and private sector (The City of New York, 2011).

Moreover, while strong support from the central government may set the stage for smart city development, the actual implementation of smart city initiatives heavily relies on the efforts and policy initiatives of local governments including streamlining local regulations and fostering harmonious collaboration among smart city stakeholders, as highlighted by research findings (Myeong et al., 2018). In summary, when considering the detailed role of the local government responsible for overseeing the region's development into a smart city, factors such as its urban management capacity, promotional strategy, and ability to unite various stakeholders are significant contributors to its growth trajectory. Therefore, this study hypothesized the effects of local government's role for the growth of smart cities on citizens' overall attitude toward local government. Thus, the following hypotheses are proposed:

H20: Perceived local government's management skill affects citizens' overall attitude toward local government role for the growth of smart cities.

H21: Perceived local government's promotion affects citizens' overall attitude toward local government role for the growth of smart cities.

H22: Perceived local government's collaboration capability affects citizens' overall attitude

toward local government role for the growth of smart cities.

3.4. Study 4: How Do Citizens Perceive the Prospect of Smart Cities in the Society?

When discussing the prospects for smart cities, it primarily refers to potential opportunities or possibilities for future success, economic growth and improved quality of life (Caragliu et al., 2011). In the context of smart cities, Batty et al. (2012) explores the future potential of smart cities, discussing how advancements in technology and data analytics can create opportunities for improving urban mobility, energy efficiency, and environmental sustainability. While growth denotes actual increases or expansions in size or extent, prospects refer to potential opportunities or possibilities for future growth or success. Growth is measurable and often the result of strategic actions, whereas prospects represent potential paths or opportunities that may necessitate further evaluation or development.

3.4.1. Effects of Proposed Factors on the Prospects of Smart Cities

Urban sustainability is increasingly recognized as a fundamental aspect of future urban development, particularly within the context of the global trend towards urbanization. Smart cities are positioned as pivotal foundations for advancing urban sustainability, as they leverage advanced technologies to address the complex interplay between people, institutions, society, and governmental policy directions (Zheng et al., 2020). In the context of smart cities, the primary focus lies in creating sustainable products and services while effectively managing limited resources and smart cities strive to develop renewable products and public services that contribute to a more sustainable environment by harnessing innovative technologies (Liu et al., 2014). These efforts are integral to fostering the prospects for a sustainable society, as they enable cities to enhance their resilience, optimize resource utilization, and mitigate environmental impacts. Thus, smart cities play a crucial role in driving forward the agenda for urban sustainability, offering innovative solutions to address the multifaceted challenges associated with urban development in the 21st century.

As outlined in earlier discussions, various attributes of smart cities, including promotional strategies (such as enhancing citizens' experiences and fostering collaboration between central and local governments), driving forces (such as support from the central government, participation of global ICT private corporations, and involvement of civic groups), public services (aimed at providing better and more efficient services for citizens), economic

factors (like international competitiveness and job creation), social factors (such as facilitating social interaction, promoting information sharing, and creating a safer society), and environmental factors (such as promoting eco-friendly energy consumption and reducing pollution) are considered influential in shaping the prospects of smart cities. These elements collectively contribute to the overall trajectory and potential success of smart city initiatives, highlighting the multifaceted nature of their impact on urban development and sustainability. Therefore, this study hypothesized the effects of proposed factors on the prospect of smart cities. Thus, the following hypotheses are proposed:

H23: Perceived promotional strategy of smart cities affects the prospect of smart cities.

H24: Perceived driving forces of smart cities affects the prospect of smart cities.

H25: Perceived public services of smart cities affect the prospect of smart cities.

H26: Perceived smart cities' economic impact affects the prospect of smart cities.

H27: Perceived smart cities' social interaction enhancement affects the prospect of smart cities.

H28: Perceived smart cities' environmental contribution affects the prospect of smart cities.

IV. Methodology

4.1. Data Collection

This study aims to assess the extent to which citizens' anticipated satisfaction with smart cities, as potential participants, is influenced by evaluating their attitudes towards various factors related to smart cities. The data for this investigation was gathered through an online survey. The survey was conducted through a professional online panel research firm. The survey was conducted in S, Korea by allocating gender, age, regional quotas, and target values. This study considered regional quotas as the application of smart cities differs across regions in S. Korea. The questionnaire begins with a brief explanation and example of smart cities and includes questions to ask awareness, definitions, and familiarity of smart cities. In particular, the questionnaires introduced examples including Songdo smart city that pursues a safer city by utilizing public CCTV and sensors throughout the city, Sejong smart city that have improved efficient transportation life for citizens, such as AI traffic lights that detect and analyze the number of vehicles at intersections and pedestrians at crosswalks in real time through image recognition and generate optimal signals, and demand-responsive buses that change routes in real time according to the demand of other passengers.

The questionnaire consists of warm-up questions, main questions, and demographic

questions. Further, the main question parts were composed of four parts: i) How do citizens perceive the impact of smart cities? For study 1; ii) How do citizens perceive the growth of smart cities? For study 2; iii) How do citizens perceive the role of local government for sustainable smart cities? For study 3; iv) How do citizens perceive the prospect of smart cities? For study 4. For study 1, this study developed questionnaire items for major factors such as quality of life, citizen experience, central government's role, technological advancement, economic value, social value, environmental value, city brand value, public service, institutional improvement, corporate participation, and open interaction. For study 2, this study developed questionnaire items for major factors such as user-centered technical support, central government support, expanding participation of private companies, association with expert groups and civic groups such as NGOs, and local government support. For study 3, this study developed questionnaire items for the role of local government including management skill, promotion, and collaboration capability with stakeholders for the sustainable growth of smart cities. For study 4, this study developed questionnaire items for major factors such as promotional strategies, driving forces, public services, economic factors, social factors and environmental factors.

This study applied a 5-point Likert scale of 1 – strongly disagree and 5 – strongly agree for major variables. Finally, the total of 400 respondents completed the survey, consisting of 165 smart city residents and 235 potential smart city residents. The survey invitation was sent to 4,393 people, and 673 adult men and women participated in the survey, therefore, the response rate was 15.3%. 239 respondents were eliminated through dropout and screening. In order to check reliability of factors developed with various questionnaire items, this study conducted Cronbach's alpha tests. The results of Cronbach alpha include the following: 0.801 for quality of life, 0.771 for citizen experience, 0.805 for central government's role, 0.822 for technological advancement, 0.816 for economic value, 0.798 for social value, 0.801 for environmental value, 0.820 for city brand value, 0.862 for public service, 0.808 for institutional improvement, 0.828 for corporate participation, 0.812 for open interaction and 0.838 for citizens' attitude in the case of study 1, 0.745 for user-centered technical support, 0.805 for central government support, 0.852 for expanding participation of private companies, 0.805 for association with expert groups, 0.875 for association with civic groups such as NGOs, 0.813 for local government support and 0.841 for growth factor in the case of study 2, 0.665 for management skill, 0.773 for promotion, 0.734 for collaboration capability, 0.601 for attitude toward the local government in the case of study 3, 0.765 for promotional strategy, 0.753 for

driving forces, 0.775 for public service, 0.728 for economic factors, 0.787 for social factor, 0.758 for environmental factor and 0.847 for overall prospect for smart cities in the case of study 4. The results are summarized in Table 4, 5, 6 and 7.

Table 4. Cronbach's Alpha for the Test of Reliability (Study 1)

Factors	Statements	Cronbach's Alpha
Citizen experience	1. Smart cities provide public services that citizens can experience in their daily lives, such as 'smart traffic lights' and 'real-time traffic information apps.' 2. Smart cities can develop further through participation and feedback from local citizens. 3. Citizens will want to live in a smart city with a system that improves the city through experience. 4. Citizens will prefer smart cities where they can experience convenient public services such as 'quick route finding'.	0.771
Central government's role	1. The government's role will be very important in creating a smart city. 2. The success of a smart city will depend on the role the government plays. 3. Citizens will want to live in a smart city where the government plays a leading role. 4. Citizens will prefer smart cities that receive continuous support under government responsibility.	0.805
Technological advancement	1. Advanced information and communication technologies (ICT) such as artificial intelligence (AI), Internet of Things (IoT), virtual reality (VR), and big data will help develop smart cities. 2. The success of a smart city will depend on how it utilizes cutting-edge information and communication technologies. 3. Citizens will want to live in a smart city equipped with cutting-edge information and communication technology. 4. Citizens will prefer smart cities that promote technological advancement.	0.822
Economic value	1. Smart cities will benefit the local economy with the participation of companies with innovative technologies. 2. Smart cities have a positive impact on revitalizing the local economy through technology-based urban innovation. 3. Smart cities have positive economic effects, including helping to attract new companies. 4. Smart city policies that benefit the local economy are needed.	0.816
Social value	1. Smart cities will contribute to the formation of sustainable communities through local urban regeneration. 2. Smart cities will have a positive impact on activating citizens' social interactions. 3. Smart cities are conducive to sustainable social development. 4. Smart cities help create social values such as mutual trust.	0.798

Environmental value	1. Smart cities will contribute to creating a sustainable environment, including the use of eco-friendly energy (e.g., solar energy, wind power, etc.). 2. Citizens will prefer smart cities that create a sustainable environment. 3. Citizens will prefer smart cities that are associated with eco-friendly policies (e.g., electric vehicles, solar energy use, etc.). 4. Citizens will prefer smart cities that address environmental problems caused by climate change (e.g., rising sea levels, extreme heat waves, severe typhoons and floods, etc.).	0.801
City brand value	1. A smart city will contribute to improving the brand value of the city where you live by creating a place where everyone can live. 2. Smart cities will have a positive impact on the city brand value of the region. 3. Citizens will want to live in a smart city that contributes to improving the city's brand value. 4. Smart city policies that focus on city brand value are needed.	0.820
Public service	1. Smart cities will have a positive impact on providing better public services for citizens. 2. Citizens will want to live in smart cities that help improve public services. 3. Citizens will prefer smart city policies that help improve public services. 4. Citizens will be more responsive to smart cities that help improve public services.	0.862
Institutional improvement	1. Smart cities will contribute to improving systems across society, such as easing various regulations related to cities and industries. 2. Smart cities will have a positive impact on institutional improvement, such as establishing new laws to provide a better life for citizens. 3. Citizens will want to live in a smart city that helps improve more rational social systems. 4. Citizens will prefer policies appropriate for smart cities.	0.808
Corporate participation	1. Smart cities require the participation of companies with cutting-edge technology for efficient city construction. 2. Smart cities will have a positive impact on the participation of various companies related to the city. 3. Smart city-related policies that allow various companies to participate are needed. 4. The diverse participation of various companies related to the city is helpful to a smart city.	0.828
Open interaction	1. Smart cities are open to all stakeholders, including citizens, governments, businesses, civic groups, and expert groups. 2. Smart cities must be able to communicate with a variety of stakeholders to come up with creative solutions. 3. Smart cities require policies to help communicate with various stakeholders related to the city. 4. Citizens will prefer a smart city created through communication between various stakeholders (e.g., government, companies, civic groups, etc.).	0.812

Citizens' overall attitude	1. Applying a smart city will improve the overall image of the area. 2. Applying smart city will help in evaluating the area 3. Applying a smart city will improve overall attitudes toward the area. 4. What is your overall attitude toward smart cities?	0.838
Quality of life	1. Smart cities should generally contribute to a better quality of life for their citizens. 2. Smart cities are believed to help improve quality of life by applying better technology. 3. Smart cities are operated to improve the quality of life of citizens through technological innovation. 4. A smart city is a city that solves various problems to improve the quality of life.	0.801

Table 5. Cronbach's Alpha for the Test of Reliability (Study 2)

Factors	Statements	Cronbach's Alpha
User-centered technical support	1. When citizens want to suggest city-related inconveniences (e.g., opinions regarding traffic issues) to local governments, a more convenient service is needed through apps or websites. 2. There is a need for further development of services such as experiencing the smart city online through apps (e.g., calling a Kakao taxi, using smart apps to file civil complaints, etc.). 3. Advanced information and communication technologies (e.g., experiencing virtual worlds as if they were real through an app called Metaverse, such as online games) will help develop smart cities. 4. There is a need to further develop services that help develop smart cities by applying cutting-edge information and communication technologies (e.g., raising urban problems and finding solutions through AI-artificial intelligence).	0.745
Central government support	1. Smart cities require continuous technological policy support from the government, including integration of various technologies (standardization, interoperability). 2. The government's long-term efforts and financial support related to smart cities need to continue. 3. An integrated smart city management approach, including regulatory improvement, personal information and data security, and support for stakeholder collaboration, will be helpful in the development of smart cities. 4. Continued support from the government will help smart cities become more competitive.	0.805
Expanding participation of private companies	1. The participation of various private companies will help technological innovation in smart cities. 2. Expanding the participation of private companies will help the development of smart cities. 3. The participation of private companies will help revitalize the market and create an industrial ecosystem within smart cities. 4. The participation of private companies will help the competitiveness of smart cities.	0.852
Association with expert groups	1. Expert opinions from various fields will be helpful in smart city decision-making.	0.805

	2. When citizens' opinions related to smart cities are expressed, the opinions of experts such as professors and researchers are helpful. 3. Referring to experts' opinions will be helpful in the development of smart cities. 4. Referring to expert opinions can help solve social problems in smart cities.	
Association with civic groups	1. Opinions from local civic groups will be helpful in smart city-related decisions. 2. When making decisions related to smart cities, it is better to listen to the opinions of local civic groups as a reference. 3. The participation of local civic groups is helpful in the development of citizen-centered smart cities. 4. If listening to the opinions of local civic groups helps solve social problems, citizens will participate more in smart cities.	0.875
Local government support	1. Local government support (financial and administrative, etc.) will be helpful in smart city decision-making. 2. I believe that decision-making related to smart cities is part of the role of local governments. 3. Local governments' operation of smart city-related services (e.g., operating traffic signals with AI to create smooth traffic flow) will be helpful in the development of smart cities. 4. If local government support helps solve social problems, citizens will respond more favorably to a smart city.	0.813
Growth factor	1. I think that overall, smart cities will grow. 2. I think that overall, smart cities will continue to develop sustainably. 3. Overall, I think that I have positive opinions about the development of smart cities.	0.841

Table 6. Cronbach's Alpha for the Test of Reliability (Study 3)

Factors	Statements	Cronbach's Alpha
Management	1. I believe that creating a smart city is one of the important roles of local governments. 2. I believe that local governments should play a role in participating in the operation of smart cities together with citizens. 3. I think local governments are playing their role well for the growth of smart cities.	0.665
Promotion	1. I think local governments should interact with citizens and inform them of the meaning of smart cities. 2. I think local governments should do more to promote the purpose of smart cities to citizens.	0.773
Collaboration	1. Local governments must work closely with the central government to create smart cities. 2. Local governments must work closely with domestic and foreign private companies to create smart cities. 3. Local governments must work closely with NGOs and other civic groups to create smart cities.	0.734
Attitude Toward local government	1. I think that I have positive attitude toward performance of local government for the growth of smart cities.	0.601

	2. Overall, my satisfaction with the role of local governments in the growth of smart cities is positive.	

Table 7. Cronbach's Alpha for the Test of Reliability (Study 4)

Factors	Statements	Cronbach's Alpha
Promotional strategy	1. Citizens' experience of public services related to urban innovation (e.g., AI traffic lights and demand-responsive buses) helps promote smart cities. 2. Having a more efficient system in which citizens directly propose and adopt innovative public services (e.g., an app that can check river flooding in real time) is useful in promoting smart cities. 3. The central government and local governments must cooperate with each other to promote smart cities to citizens.	0.765
Driving forces	1. Establishing a support system (e.g., improving unnecessary regulations) by central ministries can be helpful in the continued promotion of smart cities. 2. Continued cooperation between the government and local governments can be helpful in creating smart cities. 3. Attracting world-class ICT companies (e.g., IBM, Microsoft, Cisco, etc.) will help create a smart city. 4. Strengthening the technological capabilities of domestic companies related to smart cities and improving international competitiveness will contribute to the advancement of smart cities. 5. The participation of civic groups such as NGOs will help in the continued promotion of smart cities.	0.753
Public service	1. Smart cities are useful because citizens can use data-based public services. 2. Smart cities can provide better public services to citizens by applying new technologies. 3. Smart cities can help citizens' lives by providing efficient public services.	0.775
Economic factors	1. Companies involved in smart city creation can have the opportunity to gain international competitiveness through the development of new technologies. 2. If specialized products related to 'Korean-style smart cities', such as urban smart city construction and operation know-how, are developed and exported overseas, it will be helpful to the national economy. 3. Smart cities can bring positive economic effects (e.g., job creation, etc.) by fostering new industries.	0.728
Social factor	1. Citizens can have the opportunity to interact with others based on public data (e.g., find quick directions, find a conscientious hospital (dentist), search for good restaurants, etc.). 2. Smart cities can share social information between users by utilizing SNS and mobile app services. 3. Smart cities provide mobile app services (e.g. safety and disaster text messaging services, etc.) to provide trust in society.	0.787
Environmental factor	1. Smart cities help reduce environmental pollution (e.g. using public transportation such as electric cars or electric buses).	0.758

	2. Smart cities must provide opportunities to protect the environment through appropriate measures against abnormal climate conditions such as global warming. 3. Smart cities contribute to creating sustainable cities by utilizing eco-friendly energy such as solar and wind power.	
Overall prospect for smart cities	1. In Korea, smart cities will contribute to grow for the overall economic development. 2. Smart cities will have a positive impact on urban sustainability. 3. I think that I have positive opinion regarding the growth of smart cities. 4. Smart cities will continue to grow in Korea.	0.847

Among respondents, 50.0% were female and 50.0% were male. Among respondents, 6.0% were working at educational institution, 2.8% were working at central government, 1.8% were working at local government, 6.0% were working at public sector, 36.5% were working at profit sector, 9.0% were self-employed, 2.0% were working at research institution, 5.3% were working at non-profit organization, 14.3% were housewives, 7.8% were students, and 8.8% were others. Among respondents, 37.5% lived in Seoul, 17.5% lived in Sejong, 7.5% lived in Busan, 7.5% lived in Daegu, 7.5% lived in Incheon, 7.5% lived in Gwangju, 7.5% % lived in Daejeon and 7.5% lived in Ulsan. Regarding age groups, 8.5% were 21-24 years old, 13.0% were 25-29 years old, 13.0% were 30-34 years old, 12.5% were 35-39 years old, 8.0% were 40-44 years old, 11.0% were 45-49 years old, 11.5% were 50-54 years old, 8.0% were over 50-59 years old, 8.0% were over 60-64 years old and 6.5% were over 65 years old. In terms of education level, 0.8% had middle school graduate, 22.0% had high school graduate, 10.8% had 2-year associate degree, 56.0% had bachelor's degree, 9.0% had master's degree, and 1.5% had Ph.D. degree. For marital status, 60.5% were married and 39.5% were unmarried. Regarding average annual salary, 26.5% earned below 10,000,000 KRW, 3.5% earned more or equal to 10,000,000 ~ below 20,000,000 KRW, 14.8% earned more or equal to 20,000,000 ~ below 30,000,000 KRW, 20.5% earned more or equal to 30,000,000 ~ below 40,000,000 KRW, 12.8% earned more or equal to 40,000,000 ~ below 50,000,000 KRW, 7.0% earned more or equal to 50,000,000 ~ below 60,000,000 KRW, 5.0% earned more or equal to 60,000,000 ~ below 70,000,000 KRW, and 10.0% earned more or equal to 70,000,000 KRW. Table 8 summarized demographic characteristic of respondents.

Among respondents, 73.5% answered that they have ever heard of smart cities, while 26.5% have not ever heard of smart cities. Among respondents, 41.3% answered that they live in smart cities, while 58.7% don't live in smart cities.

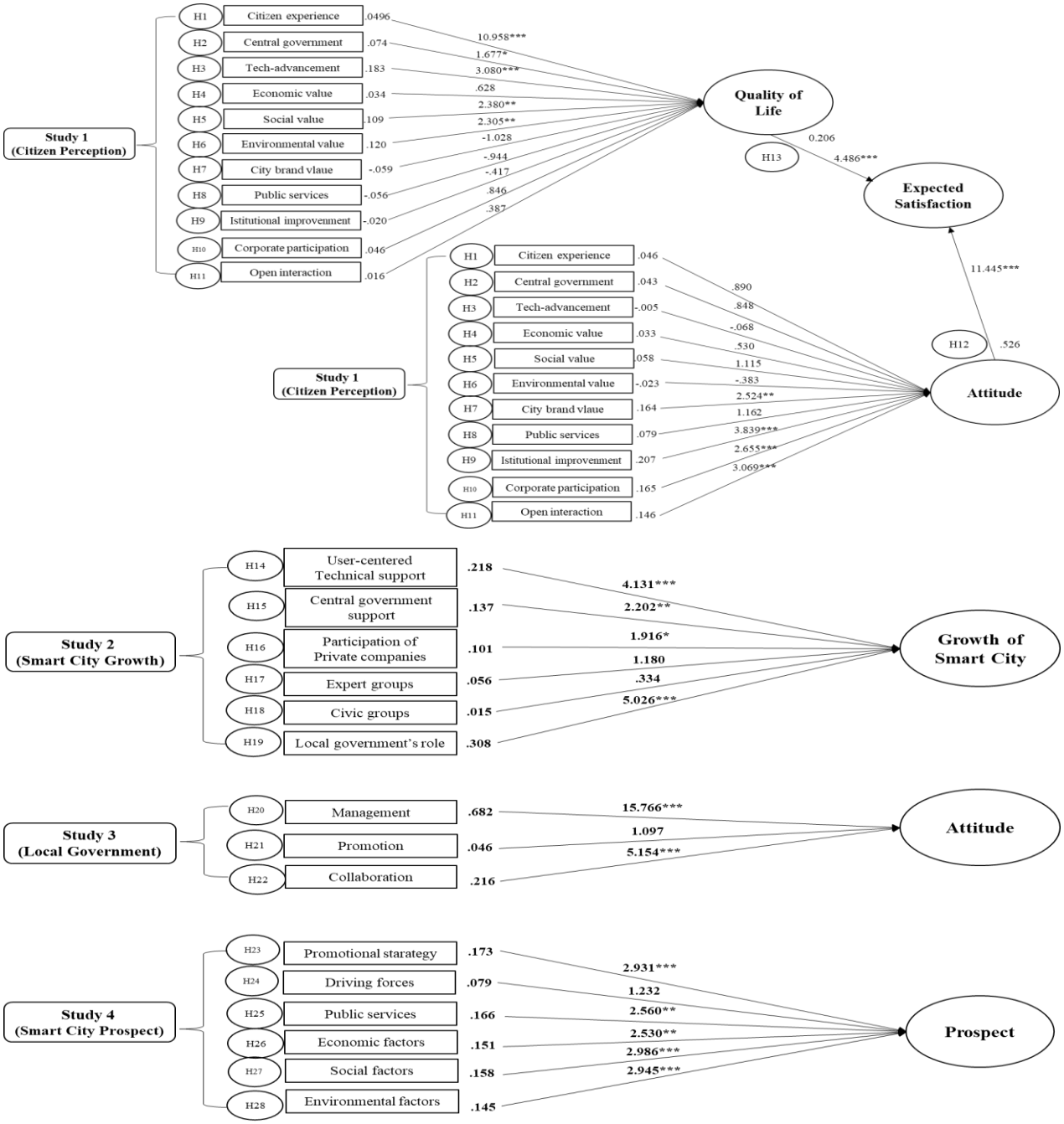
Table 8. Summary of Demographics

Category	Citizens (400)	
	%	*N*
Gender		
Male	50.0%	(200)
Female	50.0%	(200)
Occupation		
Employee in the educational institution	6.0%	(24)
Central government officials	2.8%	(11)
Local government officials	1.8%	(7)
Employee in the public sector	6.0%	(24)
Employee in the profit sector	36.5%	(146)
Self-employed	9.0%	(36)
Employee in the research institution	2.0%	(8)
Employee in non-profit organization	5.3%	(21)
Housewife	14.3%	(57)
Student	7.8%	(31)
Others	8.8%	(35)
Residency		
Seoul	37.5%	(150)
Sejong	17.5%	(70)
Busan	7.5%	(30)
Daegu	7.5%	(30)
Incheon	7.5%	(30)
Gwangju	7.5%	(30)
Daejeon	7.5%	(30)
Ulsan	7.5%	(30)
Age		
21-24 years old	8.5%	(34)
25-29 years old	13.0%	(52)
30-34 years old	13.0%	(52)
35-39 years old	12.5%	(50)
40-44 years old	8.0%	(32)
45-49 years old	11.0%	(44)
50-54 years old	11.5%	(46)
55-59 years old	8.0%	(32)
60-64 years old	8.0%	(32)
More than 65 years old	6.5%	(26)
Education		
Middle School graduate	0.8%	(3)
High school graduate	22.0%	(88)
2-year associated degree	10.8%	(43)
Bachelor degree	56.0%	(224)
Master degree	9.0%	(36)
Ph.D. degree	1.5%	(6)
Marriage		
Married	60.5%	(242)
Unmarried	39.5%	(158)
Average Annual Salary		
Below KRW 10,000,000	26.5%	(106)
More or equal to KRW 10,000,000 ~ below KRW 20,000,000	3.5%	(14)
More or equal to KRW 20,000,000 ~ below KRW 30,000,000	14.8%	(59)
More or equal to KRW 30,000,000 ~ below KRW 40,000,000	20.5%	(82)
More or equal to KRW 40,000,000 ~ below KRW 50,000,000	12.8%	(51)
More or equal to KRW 50,000,000 ~ below KRW 60,000,000	7.0%	(28)
More or equal to KRW 60,000,000 ~ below KRW 70,000,000	5.0%	(20)
More or equal to KRW 70,000,000	10.0%	(40)

4.2. Data Analysis

The multiple regression analysis for studies 1, 2, 3 and 4 is shown in figure 2 below.

Figure 2. The Logic Model of Multiple Regression Analysis in Studies 1, 2, 3 & 4



Note: This figure is an integration of the multiple regressions that are modeled and analyzed in this study.

4.2.1. Study 1: How do Citizens Perceive the Impact of Smart Cities in the Society?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including quality of life, citizen experience, central government's role, technological advancement, economic value, social value, environmental value, city brand value, public service, institutional improvement, corporate participation, open interaction, and citizens' overall attitude. Table 9 summarized the results of factor analysis for each factor of smart cities.

Table 9. Component Matrix: Factors of Smart Cities

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9
Quality of life 2	Smart cities are believed to help improve quality of life by applying better technology.	.812								
Quality of life 3	Smart cities are operated to improve the quality of life of citizens through technological innovation.	.812								
Quality of life 1	Smart cities should generally contribute to a better quality of life for their citizens.	.782								
Quality of life 4	A smart city is a city that solves various problems to improve the quality of life.	.759								
Citizen experience 4	Citizens will prefer smart cities where they can experience convenient public services such as 'quick route finding'.		.795							
Citizen experience 1	Smart cities provide public services that citizens can experience in their daily lives, such as 'smart traffic lights' and 'real-time traffic information apps.'		.779							
Citizen experience 3	Citizens will want to live in a smart city with a system that improves the city through experience.		.759							
Citizen experience 2	Smart cities can develop further through participation and feedback from local citizens.		.748							
Central government's role 1	The government's role will be very important in creating a smart city.			.819						
Central government's role 4	Citizens will prefer smart cities that receive continuous support under government responsibility.			.815						
Central government's role 2	The success of a smart city will depend on the role the government plays.			.784						

Central government's role 3	Citizens will want to live in a smart city where the government plays a leading role.			.760						
Technological advancement 3	Citizens will want to live in a smart city equipped with cutting-edge information and communication technology.				.836					
Technological advancement 2	The success of a smart city will depend on how it utilizes cutting-edge information and communication technologies.				.806					
Technological advancement 1	Advanced information and communication technologies (ICT) such as artificial intelligence (AI), Internet of Things (IoT), virtual reality (VR), and big data will help develop smart cities.				.803					
Technological advancement 4	Citizens will prefer smart cities that promote technological advancement.				.787					
Economic value 1	Smart cities will benefit the local economy with the participation of companies with innovative technologies.					.820				
Economic value 2	Smart cities have a positive impact on revitalizing the local economy through technology-based urban innovation.					.813				
Economic value 3	Smart cities have positive economic effects, including helping to attract new companies.					.793				
Economic value 4	Smart city policies that benefit the local economy are needed.					.785				
Social value 1	Smart cities will contribute to the formation of sustainable communities through local urban regeneration.						.806			
Social value 2	Smart cities will have a positive impact on activating citizens' social interactions.						.801			
Social value 4	Smart cities help create social values such as mutual trust.						.787			
Social value 3	Smart cities are conducive to sustainable social development.						.765			
Environmental value 3	Citizens will prefer smart cities that are associated with eco-friendly policies (e.g., electric vehicles, solar energy use, etc.)							.830		
Environmental value 4	Citizens will prefer smart cities that address environmental problems caused by climate change (e.g., rising sea levels, extreme heat waves, severe typhoons and floods, etc.).							.788		
Environmental value 2	Citizens will prefer smart cities that create a sustainable environment.							.786		

Environmental value 1	Smart cities will contribute to creating a sustainable environment, including the use of eco-friendly energy (e.g., solar energy, wind power, etc.).							.762		
City brand value 1	A smart city will contribute to improving the brand value of the city where you live by creating a place where everyone can live.								.822	
City brand value 2	Smart cities will have a positive impact on the city brand value of the region.								.816	
City brand value 3	Citizens will want to live in a smart city that contributes to improving the city's brand value.								.797	
City brand value 4	Smart city policies that focus on city brand value are needed.								.789	
Public service 4	Citizens will be more responsive to smart cities that help improve public services.									.864
Public Service 2	Citizens will want to live in smart cities that help improve public services.									.846
Public Service 1	Smart cities will have a positive impact on providing better public services for citizens.									.839
Public Service 3	Citizens will prefer smart city policies that help improve public services.									.815
Institutional improvement 2	Smart cities will have a positive impact on institutional improvement, such as establishing new laws to provide a better life for citizens.								.835	
Institutional improvement 3	Citizens will want to live in a smart city that helps improve more rational social systems.								.815	
Institutional improvement 4	Citizens will prefer policies appropriate for smart cities.								.785	
Institutional improvement 1	Smart cities will contribute to improving systems across society, such as easing various regulations related to cities and industries.								.752	
Corporate participation 1	Smart cities require the participation of companies with cutting-edge technology for efficient city construction.							.821		
Corporate participation 2	Smart cities will have a positive impact on the participation of various companies related to the city.							.816		
Corporate participation 3	Smart city-related policies that allow various companies to participate are needed.							.808		
Corporate participation 4	The diverse participation of various companies related to the city is helpful to a smart city.							.804		

Open interaction 2	Smart cities must be able to communicate with a variety of stakeholders to come up with creative solutions.						.823			
Open interaction 4	Citizens will prefer a smart city created through communication between various stakeholders (e.g., government, companies, civic groups, etc.).						.802			
Open interaction 3	Smart cities require policies to help communicate with various stakeholders related to the city.						.788			
Open interaction 1	Smart cities are open to all stakeholders, including citizens, governments, businesses, civic groups, and expert groups.						.785			
Overall attitude 1	Applying a smart city will improve the overall image of the area.					.832				
Overall attitude 3	Applying a smart city will improve overall attitudes toward the area.					.830				
Overall attitude 2	Applying smart city will help in evaluating the area					.823				
Overall attitude 4	What is your overall attitude toward smart cities?					.798				

This study applied factor scores for multiple regression analysis to find out the significance of each factor on overall attitude of citizens toward smart cities. ANOVA results showed that *R-square* = .589 and overall, the regression model was significant with $F = 50.563$ (at alpha of 0.01 level). As summarized in Table 10, the results showed that effects of city brand value, institutional improvement, corporate participation and open interaction on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level H7a, 9a, 10a and 11a were significantly accepted. Among significant factors, effect size for institutional improvement showed greater than other factors, followed by corporate participation, city brand value and open interaction. Therefore, the results found that how citizens perceive smart cities with focus on the institutional improvement affects overall attitude toward the smart cities with greater effect size.

Table 10. Effects of Factors on Overall Attitudes of Citizens

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Citizen experience → Attitude (H1a)	.046 (.890)
Central government's role → Attitude (H2a)	.043 (.848)
Technological advancement → Attitude (H3a)	-.005 (-.068)
Economic value → Attitude (H4a)	.033 (.530)
Social value → Attitude (H5a)	.058 (1.115)

Environmental value → Attitude (H6a)	-.023 (-.383)
City brand value → Attitude (H7a)	.164 (2.524**)
Public service → Attitude (H8a)	.079 (1.162)
Institutional improvement → Attitude (H9a)	.207 (3.839***)
Corporate participation → Attitude (H10a)	.165 (2.655***)
Open interaction → Attitude (H11a)	.146 (3.069***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

This study applied factor scores for multiple regression analysis to find out the significance of each factor on quality of life in smart cities. ANOVA results showed that *R-square* = .682 and overall, the regression model was significant with $F = 75.702$ (at alpha of 0.01 level). As summarized in Table 11, the results showed that effects of citizen experience and technological advancement on quality of life were significant at alpha 0.01 level and effects of social value and environmental value on quality of life were significant at alpha 0.05 level. The results also showed that effects of central government's role on quality of life were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H1b, 3b, 5b and 6b were accepted. Among significant factors, effect size for citizen experience showed greater than other factors, followed by technological advancement, environmental value and social value. Therefore, the results found that how citizens perceive citizen experience affects quality of life in smart cities with greater effect size.

Table 11. Effects of Factors on Quality of Life

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Citizen experience → Quality of Life (H1b)	.496 (10.958***)
Central government's role → Quality of Life (H2b)	.074 (1.677*)
Technological advancement → Quality of Life (H3b)	.183 (3.080***)
Economic value → Quality of Life (H4b)	.034 (.628)
Social value → Quality of Life (H5b)	.109 (2.380**)
Environmental value → Quality of Life (H6b)	.120 (2.305**)
City brand value → Quality of Life (H7b)	-.059(-1.028)
Public service → Quality of Life (H8b)	-.056(-.944)
Institutional improvement → Quality of Life (H9b)	-.020(-.417)
Corporate participation → Quality of Life (H10b)	.046(.846)
Open interaction → Quality of Life (H11b)	.016(.387)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

Table 12 is provided to compare multiple regression analyses in the cases of dependent variables including overall attitude toward smart cities and quality of life (Table 10 and 11). As summarized in Table 12, by applying alpha 0.01 level and 0.05 level, the results showed that effects of city brand value, institutional improvement, corporate participation and open interaction on overall attitude of citizens toward smart cities were significant. H7a, 9a, 10a and 11a were significantly accepted in the case of dependent variable as overall attitude toward smart cities. By applying alpha 0.01 level and 0.05 level, the results also found that effects of citizen experience, technological advancement, social value and environmental value on quality of life in smart cities were significant. H1b, 3b, 5b and 6b were significantly accepted in the case of dependent variable as quality of life in smart cities. The effect size of institutional improvement on overall attitude toward smart cities showed greater than other factors, while the effect size of citizen experience on quality of life showed greater than other factors. Therefore, the results found that how citizens perceive smart cities with focus on institutional improvement and city brand value and how citizens expect to participate more in smart cities that focus on corporate participation and open interaction in society affect overall attitude in smart cities. The results also found that how citizens prefer citizen experience, how citizens expect technological advancement, how citizens perceive environmental value and social value affect quality of life in smart cities. The results found that there were no independent variables of common significance for both overall attitude and quality of life. The results also found that effects of economic value and public service on both overall attitude toward smart cities and quality of life do not show significance.

Table 12. Comparison of Regression Analysis by Dependent Variable

Variable (Independent)	Standardized Coefficient (*t*-value-Sig)	
	Variable (dependent)	
	Overall Attitudes (a)	Quality of Life (b)
Citizen experience (H1)	.046 (.890)	.496 (10.958***)
Central government's role (H2)	.043 (.848)	.074 (1.677*)
Technological advancement (H3)	-.005 (-.068)	.183 (3.080***)
Economic value (H4)	.033 (.530)	.034 (.628)
Social value (H5)	.058 (1.115)	.109 (2.380**)
Environmental value (H6)	-.023 (-.383)	.120 (2.305**)
City brand value (H7)	.164 (2.524**)	-.059(-1.028)
Public service (H8b)	.079 (1.162)	-.056(-.944)
Institutional improvement (H9)	.207 (3.839***)	-.020(-.417)
Corporate participation (H10)	.165 (2.655***)	.046(.846)

Open interaction with Stakeholders (H11)	.146 (3.069***)	.016(.387)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

This study applied factor scores for regression analysis to find out the significance of overall attitude and quality of life on expected satisfaction toward smart cities. As summarized in Table 13, for the effects of overall attitude and quality of life on expected satisfaction toward smart cities, ANOVA results showed that *R-square* = .445 and overall, the regression model was significant with $F = 158.919$ (at alpha 0.01 level). The results showed that effects of overall attitude and quality of life on expected satisfaction were significant. Therefore, H12, 13 were significantly accepted. Therefore, the results found that how citizens perceive smart cities with a positive overall attitude and quality of life affect expected satisfaction with smart cities.

Table 13. Effects of Factors on Expected Satisfaction toward Smart Cities

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Overall Attitude → Expected Satisfaction (H12)	.526 (11.445***)
Quality of Life → Expected Satisfaction (H13)	.206 (4.486***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

4.2.2. Study 2: How do Citizens Perceive the Growth of Smart Cities?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including user-centered technical support, central government support, expanding participation of private companies, association with expert groups and civic groups such as NGOs, and local government support. Table 14 summarized the results of factor analysis for each factor for the growth of smart cities.

Table 14. Component Matrix: Factors for the Growth of Smart Cities

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9
User-centered technical support 4	There is a need to further develop services that help develop smart cities by applying cutting-edge information and communication technologies (e.g., raising urban problems and finding solutions through AI-artificial intelligence).	.818								
User-centered technical support 2	There is a need for further development of services such as experiencing the smart city online through apps (e.g., calling a Kakao taxi, using	.794								

	smart apps to file civil complaints, etc.).									
User-centered technical support 1	When citizens want to suggest city-related inconveniences (e.g., opinions regarding traffic issues) to local governments, a more convenient service is needed through apps or websites.	.760								
User-centered technical support 3	Advanced information and communication technologies (e.g., experiencing virtual worlds as if they were real through an app called Metaverse, such as online games) will help develop smart cities.	.651								
Central government support 1	Smart cities require continuous technological policy support from the government, including integration of various technologies (standardization, interoperability).		.825							
Central government support 4	Continued support from the government will help smart cities become more competitive.		.818							
Central government support 2	The government's long-term efforts and financial support related to smart cities need to continue.		.780							
Central government support 3	An integrated smart city management approach, including regulatory improvement, personal information and data security, and support for stakeholder collaboration, will be helpful in the development of smart cities.		.756							
Expanding participation of private companies 1	The participation of various private companies will help technological innovation in smart cities.			.839						
Expanding participation of private companies 4	The participation of private companies will help the competitiveness of smart cities.			.838						
Expanding participation of private companies 2	Expanding the participation of private companies will help the development of smart cities.			.828						
Expanding participation of private companies 3	The participation of private companies will help revitalize the market and create an industrial ecosystem within smart cities.			.825						
Association with expert groups 3	Referring to experts' opinions will be helpful in the development of smart cities.				.817					

Association with expert groups 1	Expert opinions from various fields will be helpful in smart city decision-making.				.809					
Association with expert groups 2	When citizens' opinions related to smart cities are expressed, the opinions of experts such as professors and researchers are helpful.				.779					
Association with expert groups 4	Referring to expert opinions can help solve social problems in smart cities.				.774					
Association with civic groups 2	When making decisions related to smart cities, it is better to listen to the opinions of local civic groups as a reference.					.863				
Association with civic groups 1	Opinions from local civic groups will be helpful in smart city-related decisions.					.854				
Association with civic groups 3	The participation of local civic groups is helpful in the development of citizen-centered smart cities.					.849				
Association with civic groups 4	If listening to the opinions of local civic groups helps solve social problems, citizens will participate more in smart cities.					.845				
Local government support 1	Local government support (financial and administrative, etc.) will be helpful in smart city decision-making.						.821			
Local government support 4	If local government support helps solve social problems, citizens will respond more favorably to a smart city.						.821			
Local government support 3	Local governments' operation of smart city-related services (e.g., operating traffic signals with AI to create smooth traffic flow) will be helpful in the development of smart cities.						.792			
Local government support 2	I believe that decision-making related to smart cities is part of the role of local governments.						.770			
Growth factor 1	I think that overall, smart cities will grow.							.910		
Growth factor 2	I think that overall, smart cities will continue to develop sustainably.							.880		
Growth factor 3	Overall, I think that I have positive opinions about the development of smart cities.							.823		

This study applied factor scores for multiple regression analysis to find out the significance of each factor on the growth of smart cities. ANOVA results showed that *R-square* = .537 and overall, the regression model was significant with $F = 76.006$ (at alpha of 0.01 level).

As summarized in Table 15, by applying alpha 0.01 level and 0.05 level, the results showed that effects of user-centered technical support, central government support and local government support on the growth of smart cities were significant. The results also showed that effects of expanding participation of private companies on the growth of smart cities were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H14, 15 and 19 were significantly accepted. Among significant factors, effect size for local government support showed greater than other factors, followed by user-centered technical support and central government support. Therefore, the results found that how citizens perceive smart cities with local government support affect the growth of smart cities with greater effect size. The results found that how citizens consider to participate more in smart cities with user-centered technical support and central government support affect the growth of smart cities. The results also found that effects of association with expert groups and association with civic groups on the growth of smart cities showed no significance.

Table 15. Effects of Factors on the Growth of Smart Cities

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
User-centered technical support → Growth (H14)	.218 (4.131***)
Central government support → Growth (H15)	.137 (2.202**)
Expanding participation of private companies → Growth (H16)	.101 (1.916*)
Association with expert groups → Growth (H17)	.065 (1.180)
Association with civic groups → Growth (H18)	.015 (.334)
Local government support → Growth (H19)	.308 (5.026***)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ denotes statistical significance

4.2.3. Study 3: How do Citizens Perceive the Role of Local Government for the Growth of Sustainable Smart cities?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including local government's management, promotion, and collaboration effort for the sustainable growth of smart cities. Table 16 summarized the results of factor analysis for each factor of the role of local government.

Table 16. Component Matrix: Factors of the Role of local Government

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9

Management 1	I believe that creating a smart city is one of the important roles of local governments.	.851								
Management 2	I believe that local governments should play a role in participating in the operation of smart cities together with citizens	.831								
Management 3	I think local governments are playing their role well for the growth of smart cities	.645								
Promotion 1	I think local governments should interact with citizens and inform them of the meaning of smart cities.		.903							
Promotion 2	I think local governments should do more to promote the purpose of smart cities to citizens.		.903							
Collaboration effort 2	Local governments must work closely with domestic and foreign private companies to create smart cities.				.823					
Collaboration effort 1	Local governments must work closely with the central government to create smart cities.				.827					
Collaboration effort 3	Local governments must work closely with NGOs and other civic groups to create smart cities.				.769					
Attitude Toward local Government 1	I think that I have positive attitude toward performance of local government for the growth of smart cities.					.846				
Attitude Toward local Government 2	Overall, my satisfaction with the role of local governments in the growth of smart cities is positive.					.846				

This study applied factor scores for multiple regression analysis to find out the significant of each factor. ANOVA results showed that *R-square* = .674 and overall, the regression model was significant with $F = 204.590$ (at alpha of 0.01 level). As summarized in Table 17, the results showed that effects of local government's management skill, local government's collaboration capability with central government, business, and non-profit organization such as NGO on citizens' overall attitude toward local governments were significant. Therefore, H20 and 22 were significantly accepted. Among significant factors, effect size for local government's management skill showed greater than other factors, followed local government's collaboration capability with central government, business, and non-profit organization such as NGO. Therefore, the results found that how citizens perceive smart cities under local government's

management skill on citizens' overall attitude toward the role of local governments in smart cities with greater effect size. The results also found that effects of local government's promotional activity to inform meaning and purpose of smart cities on citizens' overall attitude toward the role of local governments for the growth of smart cities showed no significance.

Table 17. Effects of Proposed Factors on Citizens' Overall Attitude toward Role of Local Government

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Local government's management skill → Attitude (H20)	.682 (15.766***)
Local government's promotional activity → Attitude (H21)	.046 (1.097)
Local government's collaboration capability → Attitude (H22)	.216 (5.154***)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ denotes statistical significance

4.2.4. Study 4: How do Citizens Perceive the Prospect of Smart Cities?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including promotional strategy, driving forces, public service, economic factor, social factor, and environmental factor for the prospect of smart cities. Table 18 summarized the results of factor analysis for each factor of the prospect of smart cities.

Table 18. Component Matrix: Factors of the Prospect of Smart Cities

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9
Promotional strategy 1	Citizens' experience of public services related to urban innovation (e.g., AI traffic lights and demand-responsive buses) helps promote smart cities.	.839								
Promotional strategy 2	Having a more efficient system in which citizens directly propose and adopt innovative public services (e.g., an app that can check river flooding in real time) is useful in promoting smart cities.	.833								
Promotional strategy 3	The central government and local governments must cooperate with each other to promote smart cities to citizens.	.801								
Driving forces 2	Continued cooperation between the government and local governments can be helpful in creating smart cities.		.807							
Driving forces 1	Establishing a support system (e.g., improving unnecessary regulations) by central ministries can be helpful in the continued promotion of smart		.785							

	cities.									
Driving forces 4	Strengthening the technological capabilities of domestic companies related to smart cities and improving international competitiveness will contribute to the advancement of smart cities.		.755							
Driving forces 3	Attracting world-class ICT companies (e.g., IBM, Microsoft, Cisco, etc.) will help create a smart city.		.753							
Driving forces 5	The participation of civic groups such as NGOs will help in the continued promotion of smart cities.		.448							
Public service 2	Smart cities can provide better public services to citizens by applying new technologies.			.848						
Public service 3	Smart cities can help citizens' lives by providing efficient public services.			.833						
Public service 1	Smart cities are useful because citizens can use data-based public services.			.809						
Economic factor 2	If specialized products related to ‘Korean-style smart cities’, such as urban smart city construction and operation know-how, are developed and exported overseas, it will be helpful to the national economy.				.835					
Economic factor 3	Smart cities can bring positive economic effects (e.g., job creation, etc.) by fostering new industries.				.791					
Economic factor 1	Companies involved in smart city creation can have the opportunity to gain international competitiveness through the development of new technologies.				.788					
Social factor 1	Citizens can have the opportunity to interact with others based on public data (e.g., find quick directions, find a conscientious hospital (dentist), search for good restaurants, etc.).					.858				
Social factor 2	Smart cities can share social information between users by utilizing SNS and mobile app services.					.837				
Social factor 3	Smart cities provide mobile app services (e.g. safety and disaster text messaging services, etc.) to provide trust in society					.818				

Environmental factor 3	Smart cities contribute to creating sustainable cities by utilizing eco-friendly energy such as solar and wind power.						.853			
Environmental factor 1	Smart cities help reduce environmental pollution (e.g. using public transportation such as electric cars or electric buses).						.818			
Environmental factor 2	Smart cities must provide opportunities to protect the environment through appropriate measures against abnormal climate conditions such as global warming.						.791			
Overall prospect 1	In Korea, smart cities will contribute to overall economic development.							.876		
Overall prospect 2	Smart cities will have a positive impact on urban sustainability.							.856		
Overall prospect 3	I think that I have positive opinion regarding the growth of smart cities.							.817		
Overall prospect 4	Smart cities will continue to grow in Korea.							.766		

This study applied factor scores for multiple regression analysis to find out the significance of each factor on the prospect of smart cities. ANOVA results showed that *R-square* = .576 and overall, the regression model was significant with $F = 88.958$ (at alpha of 0.01 level). As summarized in Table 19, by applying alpha 0.01 level and 0.05 level, the results showed that effects of promotional strategy, public service, economic factor, social factor, and environmental factor on the prospect of smart cities were significant. Therefore, by applying alpha 0.01 level and 0.05 level, H23, 25, 26, 27 and 28 were significantly accepted. Among significant factors, effect size for promotional strategy showed greater than other factors, followed by public service, social factor, economic factor and environmental factor. Therefore, the results found that how citizens perceive smart cities with promotional strategy affect the prospect of smart cities with greater effect size. The results also found that effects of driving forces for developing smart cities on the prospect of smart cities showed no significance.

Table 19. Effects of Smart Cities Factors on Overall Prospect of Smart Cities

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Promotional strategy → Prospect (H23)	.173 (2.931***)
Driving forces → Prospect (H24)	.079 (1.232)
Public service → Prospect (H25)	.166 (2.560**)
Economic factor → Prospect (H26)	.151 (2.530**)

Social factor → Prospect (H27)	.158 (2.986***)
Environmental factor → Prospect (H28)	.145 (2.945***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

V. Conclusion

5.1. The Summary of Findings

The purpose of this study is to explore factors that affect citizens' perception and overall attitude toward smart cities in relation to the impact on smart cities, the growth of smart cities, the role of local governments for the growth of sustainable smart cities, and the prospects of smart cities.

Firstly, regarding how citizens perceive the impact of smart cities in study 1, the results showed that effects of city brand value, institutional improvement, corporate participation and open interaction on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level H7a, 9a, 10a and 11a were significantly accepted. Among significant factors, effect size for institutional improvement showed greater than other factors, followed by corporate participation, city brand value and open interaction. Therefore, the results found that how citizens perceive smart cities with focus on the institutional improvement affects citizens' overall attitude toward smart cities with greater effect than other factors. The results of this study also showed that effects of citizen experience, technological advancement, social value and environmental value on quality of life were significant. The results also showed that effects of central government's role on quality of life were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H1b, 3b, 5b and 6b were accepted. Among significant factors, effect size for citizen experience showed greater than other factors, followed by technological advancement, environmental value and social value. Therefore, the results found that how citizens perceive citizen experience affects quality of life in smart cities with greater effect size. The results found that factors that are associated with overall attitude and quality of life showed different. The results found that significant factors that are associated with overall attitude are more related to objective evaluation and beliefs about the smart city rather than subjective impacts. The results also found that significant factors that are associated with quality of life are more related to subjective feelings and thoughts. The results also found that effects of economic value and public service on both overall attitude toward smart cities and quality of life do not show significance. Therefore, the results provide implications that citizens

may lack experience in factors such as economic value and public service, or may not perceive how those factors can influence attitude and quality of life in smart cities. The results also found that effects of overall attitude and quality of life on expected satisfaction were significant. Therefore, H12, 13 were significantly accepted. Therefore, the results found that how citizens perceive smart cities with a positive overall attitude and quality of life affect expected satisfaction with smart cities.

Secondly, regarding how citizens perceive the growth of smart cities in the society in study 2, by applying alpha 0.01 level and 0.05 level, the results showed that effects of user-centered technical support, central government support and local government support on the growth of smart cities were significant. The results also showed that effects of expanding participation of private companies on the growth of smart cities were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H14, 15 and 19 were significantly accepted. Among significant factors, effect size for local government support showed greater than other factors, followed by user-centered technical support and central government support. Therefore, the results found that how citizens perceive smart cities with local government support affects the growth of smart cities with greater effect size. The results also found that effects of association of expert groups and civic groups on the growth of smart cities do not show significance. The results implies that how citizens perceive local government support, user-centered technical support, and central government support as more significant factors in considering the growth of smart cities.

Thirdly, regarding how citizens perceive the role of local government for the growth of smart cities in study 3, the results showed that effects of local government's management skill and local government's collaboration capability with central government, business, and non-profit organization such as NGO on citizens' overall attitude toward the role of local government for the growth of smart cities were significant. Therefore, H20 and 22 were significantly accepted. Among significant factors, effect size for local government's management skill showed greater than other factors, followed local government's collaboration capability. Therefore, the results found that how citizens perceive smart cities under local government's management skill on citizens' overall attitude toward the role of local governments in smart cities with greater effect size. The results also found that effects of local government's promotional activity to inform meaning and purpose of smart cities on citizens' overall attitude toward local governments did not show significance. The results implies that how citizens perceive local government's management skill and local government's

collaboration capability with central government, business, and non-profit organization such as NGO as more significant factors in considering the role of local government for the growth of sustainable smart cities.

Lastly, regarding how citizens perceive the prospect of smart cities in study 4, by applying alpha 0.01 level and 0.05 level, the results of this study showed that effects of promotional strategy, public service, economic factor, social factor, and environmental factor on the prospect of smart cities were significant. Therefore, by applying alpha 0.01 level and 0.05 level, H23, 25, 26, 27 and 28 were significantly accepted. Among significant factors, effect size for promotional strategy showed greater than other factors, followed by public service, social factor, economic factor and environmental factor. Therefore, the results found that how citizens perceive smart cities with promotional strategy affect the prospect of smart cities with greater effect size. The results also found that effects of driving forces for developing smart cities on the prospect of smart cities showed no significance. The results implies that citizens perceive promotional strategy, public service, social factor, economic factor and environmental factor as more significant factors in expecting the prospect of smart cities.

5.2. Policy and Managerial Implications

The results of this study provide managerial and policy implications. Smart cities will be developed and established in a society with citizens' awareness of smart cities and their better understanding of its meanings and scopes. Better policies should be prepared and promoted to the public to increase awareness for the sustainable growth of smart cities. In addition, better policy preparation with regulation and the role of local government for smart cities should be also considered in a society.

There are few studies that deal with the Korean government's policies and citizens' perceptions of smart cities, and even those studies are mostly qualitative studies based on case analysis. Therefore, this study applied quantitative research using quantitatively measured data collected via an online survey of citizens by extracting variables considered more significant through literature and case studies. Through this, this study explored how citizens perceive the impact and growth of smart cities, the role of local governments for the growth of smart cities, and the prospects for smart cities. Furthermore, it presented in which direction local governments should develop and revise smart city-related policies. In this sense, this study is expected to fill the limitations and gaps by exploring citizen perception of smart cities and policy proposals by suggesting necessity of better policies for the growth and prospects of

smart city with citizen perspectives.

More specifically, based on the results of Study 1, citizens believe that institutional improvements within existing cities are still significantly lacking in the development of smart cities. Therefore, the government needs to promote smart city development through bolder policy enhancements in city-related systems. Based on the results of Study 2, citizens consider local government support to be the most important factor in the growth of smart cities. Therefore, the government needs to reorganize the existing smart city policy, which is based on government administrative and financial support, into a local government-centered approach. Ultimately, this will require implementing a more comprehensive and stable policy where local governments directly plan, develop, manage, and operate smart cities. In line with this shift in smart city policy direction, local governments must also prepare by establishing smart city-related departments, enhancing human capacity, and undertaking financial reorganization. Based on the results of Study 3, the specific role of local government is not only to cultivate efficient urban management skills but also to develop collaborative capabilities with the central government and various stakeholders including citizens, business and non-profit organization such as NGO. In other words, it is important and urgent for local governments to prepare policies on how to attract and coordinate various stakeholders including citizens involved in the sustainable growth of smart cities. Based on the results of Study 4, regarding the prospect for smart cities, citizens believe that continuous development of public smart services that reflect social, economic, and environmental values is necessary, and that a more active promotional strategy is the most important factor. Therefore, in addition to developing smart cities, the local government should actively plan and implement a tangible promotion strategy that shapes citizens' perceptions of the prospects of smart cities alongside its policies.

5.2.1. Discussion from Study 1

From Study 1, this study found that factors including city brand value, institutional improvement, corporate participation and open interaction on overall attitude toward the smart cities showed significance. This study also found that factors including of citizen experience, technological advancement, social value and environmental value on quality of life in smart cities showed significance. Smart cities are an urban plan for a more inclusive community that creates an economically more livable society through citizen participation and attracting businesses. Therefore, the results meet the meanings of smart cities that considered a more

inclusive community that creates an economically more livable society through citizen participation and attracting businesses. Among those factors on overall attitude, the effect size of institutional improvement on attitudes was higher than effects of other factors. This implies how citizens perceive smart cities that focus on institutional improvement, particularly dealing with improvement of various regulations affect attitude toward smart cities. Among those factors on quality of life, the effect size of citizen experience on quality of life was higher than effects of other factors. This implies how citizens perceive smart cities that focus on citizen experience, particularly attract citizens' participation affect quality of life in smart cities.

However, this study found that factors including citizen experience, central government's role, technological advancement, economic value, social value, environmental value, and public service on attitude toward the smart cities did not show significance. The fact that the citizen experience did not show significance in this study is a significant gap from previous studies that have emphasized citizen experience through participation in smart cities. Further, effects of economic value, social value, and environmental value on attitude toward smart cities did not show significant due to reasons such as lack of awareness of meaning of smart cities. According to Table 22, 58.7% of citizens do not think I live in smart cities, and 60.9% of citizens are not aware of what smart cities mean. This implies that citizens have heard of smart cities, but still are not properly aware of the meaning and the process of smart cities. Since citizens' awareness is low in South Korea as about 75% of citizens responded that more information and promotion about smart cities are needed, degree of awareness should be improved in order to increase citizen understanding, participation, and attitude toward the smart cities for better settlement of smart cities in a society. Further, the results of Study 1 implies the necessity of better institutional policies to attract corporate participation and create open interaction with various stakeholders to enhance citizen awareness and participation in smart cities. Moreover, it also implies that improving the quality of life, which is the main purpose of smart cities, is eventually to solve social and environmental issues through citizen participation based on advanced technology. Currently, smart cities policies focused on regulatory innovation are promoted by central government, while actual implementations for applications of smart cities are developed by local government. However, overall lack of awareness of smart cities by citizens cannot match expectation on the citizen participatory policies of smart cities promoted by governments. In addition, lower level of awareness and participation could not meet diverse successful cases that contribute to sustainable smart cities.

The results found that factors that are associated with overall attitude and quality of life showed different. The results found that factors that are associated with overall attitude and quality of life showed different. The results found that significant factors that are associated with overall attitude are more related to objective evaluation and beliefs about the smart city rather than subjective impacts. The results also found that significant factors that are associated with quality of life are more related to subjective feelings and thoughts. A previous study by Cai et al. (2021) addressed that the concept of quality of life includes aspects related to well-being as it has become more personal perception than an objective entity. Cella (1994) addressed that quality of life is understood to be subjective as it is measured from perspective and also multidimensional as its measurements include physical, emotional, and social well-being. The factors found in this study associated with quality of life such as social and environmental value could be supported by subjective perspective and multidimensional aspects of well-being by Cella (1994). An attitude by Ajzen (1989) defined as "an individual's disposition to respond favorably or unfavorably to an object, person, institution, or event, or to any other discriminable aspect of the individual's world (p.241)." Ajzen (1989) also addressed that "to go beyond attitude is a general evaluative disposition by considering the structure of domain to which it applies (p.242)." Attitude is also explained by the multicomponent view including cognition, affect, and conation Ajzen (1989), while compared to subjective perception, quality of life, attitude concepts include objective aspect such as cognition. Therefore, the results of significant factors associated with attitude and quality of life showed difference due to different definitions stated by previous studies. Questionnaire items applied to measure attitude include belief evaluation, and overall attitude regarding smart city that are supported by previous studies on attitude (Ajzen & Fishbein, 2008). Therefore, how citizen believe and evaluate that form overall attitude toward smart city is based on how it fosters city brand value, necessity policy or institutional improvement, necessity of corporation participation, and open interaction with stakeholders. How citizen perceive impacts on quality of life with the development of smart city is based on how citizen perceive experience such as smart transportation system, finding a better road system offered by app, and other city life improvement, development of advanced technology to foster smart city, social and environment value, and role of government to make better smart cities.

5.2.2. Discussion from Study 2

From Study 2, by applying alpha 0.01 level and 0.05 level this study found that factors including user-centered technical support, central government support and local government support on the growth of smart cities showed significance. Among significant factors, effect size for local government support showed greater than other factors, followed by user-centered technical support and central government support. The results also showed that effects of expanding participation of private companies on the growth of smart cities were significant at alpha 0.1 level. The results of this study implies that citizens perceive the effect of local government support is crucial for the growth of smart cities. Further, citizens also perceive that both local and central governments should consider policies related to the support of user-centered technology that attract more citizens to participate in smart cities for the sustainable growth of smart cities. The results showed consistency by considering successful smart cities that have utilized the user-centered technical support and central and local government support. Therefore, local governments need to implement policies that can introduce and develop various user-centered technologies such as Coventry City's CovJam, an online venture platform based on IBM's IT technology (Burton, 2013) and Seoul City's Metaverse Seoul that allow citizens to access smart cities more quickly and conveniently while identifying the difficulties citizens are experiencing in relation to participating in smart cities. Further, it is necessary for local governments to provide policies that are necessary for the preparation of elaborate procedures and standardized smart cities management.

The results also found that effects of association with expert groups and association with civic groups on the growth of smart cities do not show significance. By considering the fact that role of expert groups and civic groups for the growth of smart city are important, the results implies that citizens need to follow up expert groups such as open conference and aware the role of civic groups that discuss social environmental issues for the growth of smart city.

5.2.3. Discussion from Study 3

From Study 3, this study found that factors including local government's management skill and local government's collaboration capability on overall attitude toward smart cities showed significance, while the factor such as local government's promotional activity on overall attitude toward smart cities did not show significance. The results implies that the role of local governments is crucial in managing smart cities and encouraging collaboration with stakeholders including citizens to participate more actively in smart cities. Further, the results also implies that local government need to put more effort on promotion related to importance

of smart city, therefore, enhanced citizens' awareness of smart city might help form attitude toward smart city.

Regarding application of smart city supported by local government, additional analysis of this study (see Table 20 from Appendix B) found the fact that 96.2% of citizens think that the application of smart cities is important in our community supports amendment of policies for the local governments. In addition, most of citizens thought that smart cities were part of local government policies. The higher mean values of results shown in Table 20 (Appendix B) also implies how citizens perceive of smart cities operated and managed by local governments, and prefer to participate in such smart cities. It also implies that citizens believe local governments need to play a critical role in managing smart cities and collaboration with stakeholders so that citizens are more aware of the meaning of smart cities, and experience more smart cities. Therefore, policy support from local governments for the operation and management of smart cities is expected in practice so that citizens' awareness of smart cities can be raised and citizens can participate in smart cities.

5.2.4. Discussion from Study 4

From Study 4, this study found that factors including promotional strategy, public service, economic factor, social factor, and environmental factor on the prospect of smart cities showed significance. By considering the effect size, the results implies that citizens perceive that promotional strategy have a more significant impact on the prospect of sustainable smart cities. To explain results of study 4, this study applied the results from the additional analysis shown in Table 20 (Appendix B).

Additional analysis of this study (see Table 20 from Appendix B) found that 69% of citizens still do not know much about smart cities, and more than 95% of citizens believe that more information and promotion about smart cities is needed. This implies local governments in relation to the prospect of sustainable smart cities should focus on more strategic promotional policies that can more actively raise citizens' awareness of smart cities by allowing them to experience a variety of public services based on user-centered technical support. The results of this study provide managerial and policy implications how to enhance citizens' awareness and knowledge on smart cities, how to improve citizen participation, how to grow smart cities in our society.

5.2.5. Limitation and Future Study

This paper acknowledges several limitations and offers implications for future research. Firstly, the study's data collection was limited to ordinary citizens randomly sampled in South Korea, potentially restricting the generalizability of the findings. To address this, future studies could enhance the sample size of citizens who have experienced smart cities for more comprehensive data analysis. Additionally, employing structural equation modeling and considering different types of smart cities led by various stakeholders beyond citizen-centered models could offer deeper insights.

Moreover, the study did not analyze response patterns by the type of smart cities, which could be seen as a limitation. Future research could explore how different types of smart cities influence citizen awareness and attitudes. Furthermore, investigating additional factors beyond those examined in this study, particularly regarding citizens' attitudes and intentions to participate in smart cities, would enrich the analysis. This study does not contain analysis results by incorporating demographic data as control variables including age, gender and region. The reasons are as follows. The same independent variables and citizens' attitudes toward smart cities, quality of life, and expected satisfaction were set as dependent variables, with demographic data including age, gender, and region set as control variables and the same analysis was applied. However, from ANOVA and regression analysis results, it is found that there was no significant difference in the results with or without the control variables. Addressing this limitation in future studies could provide valuable insights into how these demographic factors influence perceptions of smart cities.

Secondly, despite extensive literature research on smart city cases and policies overseas, the findings of this study may be limited to the Korean context, as the data was collected exclusively from Korean participants. Since smart city initiatives and contexts can vary significantly between countries, it would be beneficial to apply the research model to different countries for comparative analysis in future studies. This comparative approach could shed light on how cultural, economic, and institutional factors shape perceptions and experiences of smart cities across diverse contexts.

Lastly, the findings of this study may primarily reflect the characteristics of smart cities promoted in South Korea, as they are based on the opinions of citizens residing in the country. The study explored citizens' overall attitudes and anticipated satisfaction with smart cities regardless of regional variations. Therefore, future research should aim to analyze citizens' satisfaction and intentions to participate based on diverse types of smart cities, considering

regional differences and characteristics. This approach would provide a more comprehensive understanding of how smart city initiatives are perceived and experienced across various regions and contexts.

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Appendix A

Questionnaire

Citizen awareness and satisfaction survey related to smart cities

Thank you for answering this survey. This survey is proposed to investigate your opinions about smart cities. Your responses will be treated strictly confidential. This survey is anonymous and intended for research purpose only. Also, this survey will be conducted with your voluntary participation. If you have experienced smart cities, please respond the questions based on your experience. If you have not experienced smart cities, please respond the questions based on what you think of smart cities.

In Korea, smart cities are defined as 'a city platform that improves the quality of life of citizens, increases urban sustainability, and fosters new industries through active intervention and participation of citizens, who are the owners of the city, by utilizing innovative technologies in the era of the 4th Industrial Revolution based on data'. Seoul smart city that is enhancing the value of the city brand by providing public services so that foreign tourists can conveniently use various apps through the Seoul Bukchon free Wi-Fi establishment project, Songdo smart city that pursues a safer city by utilizing public CCTV and sensors throughout the city, there are various smart city examples such as Sejong smart city that have improved efficient transportation life for citizens, such as AI traffic lights that detect and analyze the number of vehicles at intersections and pedestrians at crosswalks in real time through image recognition and generate optimal signals, and demand-responsive buses that change routes in real time according to the demand of other passengers.

1. Have you ever heard of smart cities?
   (1) Yes, I have heard. (2) No, I have not heard.

2. Do you think you live in a smart city?
   (1) Yes, I do (2) No, I don't

3. How much do you know about smart cities?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

4. How satisfied are you overall with the smart city?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

5. Please answer the following questions about the definition of a smart city.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	A smart city is an urban infrastructure comprised of information and communication technology (ICT) that promotes sustainable development to solve increasing urbanization problems such as housing shortage, traffic congestion, and disaster safety due to population concentration.					
2	A smart city is a digitally connected city that improves the urban environment and quality of life through better operational management.					
3	A smart city is an urban plan for a more inclusive community that creates an economically more livable society through citizen participation and attracting businesses.					
4	A smart city is an intelligent city that helps residents to live safer and more conveniently based on cutting-edge information and communication technologies (ICT) such as artificial intelligence (AI)-type CCTV, Internet of Things (IoT), virtual reality (VR), and big data.					
5	A smart city is a sustainable city that prepares for disasters caused by climate change, such as floods and landslides, through efficient energy management such as insufficient water and electricity.					

6. Choose one that best describes the purpose of a smart city.
   (1) Expansion of intelligent urban infrastructure based on technological development based on the 4th Industrial Revolution
   (2) Sustainable environmental initiative for cities against climate change (new initiative with leadership)
   (3) Creating a more efficient and functional public transportation system by applying cutting-edge technologies such as AI, IoT, and VR
   (4) Creating safer public spaces and housing for citizens
   (5) Creating a sustainable society to improve the quality of life of citizens by utilizing limited resources

7. I think I know what smart city means.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

8. I think the use of smart cities is important in our society.

←Strongly Disagreed		Neutral		Strongly Agreed→

1	2	3	4	5

9. I think it would be good if more information was provided to know what smart city means.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

10. I think there needs to be more publicity regarding smart cities to raise awareness about them.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

Study 1: Factors that affect Citizen Perception on the Attitude toward Smart Cities

11. The following questions are about the impact of smart cities on quality of life. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities should generally contribute to a better quality of life for their citizens.					
2	Smart cities are believed to help improve quality of life by applying better technology.					
3	Smart cities are operated to improve the quality of life of citizens through technological innovation.					
4	A smart city is a city that solves various problems to improve the quality of life.					

12. The following are questions about smart city-related experiences. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities provide public services that citizens can experience in their daily lives, such as ‘smart traffic lights’ and ‘real-time traffic information apps.’					
2	Smart cities can develop further through participation and feedback from local citizens.					
3	Citizens will want to live in a smart city with a system that improves the city through experience.					
4	Citizens will prefer smart cities where they can experience convenient public services such as ‘quick route finding’.					

13. The following are questions about the government's role in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed

		1	2	3	4	5
1	The government's role will be very important in creating a smart city.					
2	The success of a smart city will depend on the role the government plays.					
3	Citizens will want to live in a smart city where the government plays a leading role.					
4	Citizens will prefer smart cities that receive continuous support under government responsibility.					

14. The following are questions about technological developments in smart cities (e.g., Kakao taxi calling, bus arrival time service). Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Advanced information and communication technologies (ICT) such as artificial intelligence (AI), Internet of Things (IoT), virtual reality (VR), and big data will help develop smart cities.					
2	The success of a smart city will depend on how it utilizes cutting-edge information and communication technologies.					
3	Citizens will want to live in a smart city equipped with cutting-edge information and communication technology.					
4	Citizens will prefer smart cities that promote technological advancement.					

15. The following are questions about the economic value of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will benefit the local economy with the participation of companies with innovative technologies.					
2	Smart cities have a positive impact on revitalizing the local economy through technology-based urban innovation.					
3	Smart cities have positive economic effects, including helping to attract new companies.					
4	Smart city policies that benefit the local economy are needed.					

16. The following are questions about the social value of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will contribute to the formation of sustainable communities through local urban regeneration.					
2	Smart cities will have a positive impact on activating citizens' social interactions.					
3	Smart cities are conducive to sustainable social development.					
4	Smart cities help create social values such as mutual trust.					

17. The following are questions about the environmental impact of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will contribute to creating a sustainable environment, including the use of eco-friendly energy (e.g., solar energy, wind power, etc.).					
2	Citizens will prefer smart cities that create a sustainable environment.					
3	Citizens will prefer smart cities that are associated with eco-friendly policies (e.g., electric vehicles, solar energy use, etc.).					
4	Citizens will prefer smart cities that address environmental problems caused by climate change (e.g., rising sea levels, extreme heat waves, severe typhoons and floods, etc.).					

18. The following are questions about the city brand value of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	A smart city will contribute to improving the brand value of the city where you live by creating a place where everyone can live.					
2	Smart cities will have a positive impact on the city brand value of the region.					
3	Citizens will want to live in a smart city that contributes to improving the city's brand value.					
4	Smart city policies that focus on city brand value are needed.					

19. The following are questions about public services in smart cities (e.g., civil complaint smart app, AI traffic lights, self-driving cars, IoT-based emergency medical system, safety and disaster text

service, etc.). Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will have a positive impact on providing better public services for citizens.					
2	Citizens will want to live in smart cities that help improve public services.					
3	Citizens will prefer smart city policies that help improve public services.					
4	Citizens will be more responsive to smart cities that help improve public services.					

20. The following are questions about institutional improvement in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will contribute to improving systems across society, such as easing various regulations related to cities and industries.					
2	Smart cities will have a positive impact on institutional improvement, such as establishing new laws to provide a better life for citizens.					
3	Citizens will want to live in a smart city that helps improve more rational social systems.					
4	Citizens will prefer policies appropriate for smart cities.					

21. The following are questions about the participation of smart city-related companies. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities require the participation of companies with cutting-edge technology for efficient city construction.					
2	Smart cities will have a positive impact on the participation of various companies related to the city.					
3	Smart city-related policies that allow various companies to participate are needed.					
4	The diverse participation of various companies related to the city is helpful to a smart city.					

22. The following are questions about open interaction in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities are open to all stakeholders, including citizens, governments, businesses, civic groups, and expert groups.					
2	Smart cities must be able to communicate with a variety of stakeholders to come up with creative solutions.					
3	Smart cities require policies to help communicate with various stakeholders related to the city.					
4	Citizens will prefer a smart city created through communication between various stakeholders (e.g., government, companies, civic groups, etc.).					

23. Applying smart city will help in evaluating the area.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

24. Applying a smart city will improve the overall image of the area.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

25. Applying a smart city will improve overall attitudes toward the area.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

26. If you live in a smart city, how satisfied do you think you would be overall?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

Study 2: Necessity of Factors for the Growth of Smart Cities

27. The following are questions about user-centered technical support for smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	When citizens want to suggest city-related inconveniences (e.g., opinions regarding traffic issues) to local governments, a more convenient service is needed through apps or websites.					

2	There is a need for further development of services such as experiencing the smart city online through apps (e.g., calling a Kakao taxi, using smart apps to file civil complaints, etc.).					
3	Advanced information and communication technologies (e.g., experiencing virtual worlds as if they were real through an app called Metaverse, such as online games) will help develop smart cities.					
4	There is a need to further develop services that help develop smart cities by applying cutting-edge information and communication technologies (e.g., raising urban problems and finding solutions through AI-artificial intelligence).					

28. The following are questions about central government support for smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities require continuous technological policy support from the government, including integration of various technologies (standardization, interoperability).					
2	The government's long-term efforts and financial support related to smart cities need to continue.					
3	An integrated smart city management approach, including regulatory improvement, personal information and data security, and support for stakeholder collaboration, will be helpful in the development of smart cities.					
4	Continued support from the government will help smart cities become more competitive.					

29. The following are questions about expanding private enterprise participation in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	The participation of various private companies will help technological innovation in smart cities.					
2	Expanding the participation of private companies will help the development of smart cities.					
3	The participation of private companies will help revitalize the market and create an industrial ecosystem within smart cities.					

4	The participation of private companies will help the competitiveness of smart cities.					

30. The following are questions about the participation of smart city experts (professors, researchers) (e.g., smart city-related conferences, etc.). Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Expert opinions from various fields will be helpful in smart city decision-making.					
2	When citizens' opinions related to smart cities are expressed, the opinions of experts such as professors and researchers are helpful.					
3	Referring to experts' opinions will be helpful in the development of smart cities.					
4	Referring to expert opinions can help solve social problems in smart cities.					

31. The following are questions about civic group participation in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Opinions from local civic groups will be helpful in smart city-related decisions.					
2	When making decisions related to smart cities, it is better to listen to the opinions of local civic groups as a reference.					
3	The participation of local civic groups is helpful in the development of citizen-centered smart cities.					
4	If listening to the opinions of local civic groups helps solve social problems, citizens will participate more in smart cities.					

32. The following are questions about local government support for smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Local government support (financial and administrative, etc.) will be helpful in smart city decision-making.					
2	I believe that decision-making related to smart cities is part of the role of local governments.					

3	Local governments' operation of smart city-related services (e.g., operating traffic signals with AI to create smooth traffic flow) will be helpful in the development of smart cities.					
4	If local government support helps solve social problems, citizens will respond more favorably to a smart city.					

33. Overall, I think smart cities will develop sustainably.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

34. Overall, smart cities will grow.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

Study 3: The Role of Local Government for the Sustainable Growth of Smart Cites

35. I believe that creating a smart city is one of the important roles of local governments.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

36. I believe that local governments should play a role in participating in the operation of smart cities together with citizens.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

37. I think local governments are playing their role well for the growth of smart cities.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

38. I think local governments should interact with citizens and inform them of the meaning of smart cities.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

39. I think local governments should do more to promote the purpose of smart cities to citizens.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

40. Local governments must provide public services related to smart cities that are helpful to quality of life.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

41. I think that local governments should utilize smart cities to provide better public services.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

42. Local governments must work closely with the central government to create smart cities.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

43. Local governments must work closely with domestic and foreign private companies to create smart cities.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

44. Local governments must work closely with NGOs and other civic groups to create smart cities.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

45. Overall, my attitude toward the role of local governments in creating smart cities is positive.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

46. Overall, my satisfaction with the role of local governments in the growth of smart cities is positive.

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

Study 4: Factors that affect Prospect of Smart Cities

47. The following are questions about the promotional strategy of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Citizens' experience of public services related to urban innovation (e.g., AI traffic lights and demand-responsive buses) helps promote smart cities.					
2	Having a more efficient system in which citizens directly propose and adopt innovative public services (e.g., an app that can check river flooding in real time) is useful in promoting smart cities.					

3	The central government and local governments must cooperate with each other to promote smart cities to citizens.					

48. The following are questions about driving forces for smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Establishing a support system (e.g., improving unnecessary regulations) by central ministries can be helpful in the continued promotion of smart cities.					
2	Continued cooperation between the government and local governments can be helpful in creating smart cities.					
3	Attracting world-class ICT companies (e.g., IBM, Microsoft, Cisco, etc.) will help create a smart city.					
4	Strengthening the technological capabilities of domestic companies related to smart cities and improving international competitiveness will contribute to the advancement of smart cities.					
5	The participation of civic groups such as NGOs will help in the continued promotion of smart cities.					

49. The following are questions about public services in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities are useful because citizens can use data-based public services.					
2	Smart cities can provide better public services to citizens by applying new technologies.					
3	Smart cities can help citizens' lives by providing efficient public services.					

50. The following are questions about the economic factors of smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Companies involved in smart city creation can have the opportunity to gain international competitiveness through the development of new technologies.					
2	If specialized products related to ‘Korean-style smart cities’, such as urban smart city construction and operation know-how, are developed and exported overseas, it will be helpful to the national economy.					
3	Smart cities can bring positive economic effects (e.g., job creation, etc.) by fostering new industries.					

51. The following are questions about social factors in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Citizens can have the opportunity to interact with others based on public data (e.g., find quick directions, find a conscientious hospital (dentist), search for good restaurants, etc.).					
2	Smart cities can share social information between users by utilizing SNS and mobile app services.					
3	Smart cities provide mobile app services (e.g. safety and disaster text messaging services, etc.) to provide trust in society.					

52. The following are questions about environmental factors in smart cities. Please select according to the extent to which you agree with each of the following questions.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities help reduce environmental pollution (e.g. using public transportation such as electric cars or electric buses).					
2	Smart cities must provide opportunities to protect the environment through appropriate measures against abnormal climate conditions such as global warming.					
3	Smart cities contribute to creating sustainable cities by utilizing eco-friendly energy such as solar and wind power.					

53. What is your overall attitude toward smart cities?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

54. Are you positive about the development of smart cities?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

55. Please choose one reason why citizens do not actively participate in smart cities.

(1) Due to lack of relevant information

(2) Don’t know how to participate

(3) Due to lack of user-centered technical support

(4) Because the problems addressed in smart cities are far from real life,

(5) Not sure whether my opinion will be reflected in the smart city.

(6) Because the government and local governments are not actively involved in promoting and supporting smart cities,

56. Please respond to the following questions about the prospects for smart cities in Korea.

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Smart cities will continue to grow in Korea.					
2	In Korea, smart cities will contribute to overall economic development.					
3	In Korea, smart cities will contribute to overall social development.					
4	Smart cities will have a positive impact on social interactions between citizens.					
5	Smart cities will have a positive impact on urban sustainability.					
6	Smart cities will have a positive impact on environmental sustainability.					

57. What do you think about expanding smart cities to various cities?

←Strongly Disagreed		Neutral		Strongly Agreed→
1	2	3	4	5

58. Please select your gender.

(1) Male

(2) Female

59. Please select your occupation.

(1) Employee in the educational institution

(2) Central government officials

(3) Local government officials

(4) Employee in the public sector

(5) Employee in the profit sector

(6) Self-employed

(7) Employee in the research institution

(8) Employee in non-profit organization

(9) Housewife

(10) Student

(11) Others ( )

60. Please select your age group.
    (1) 20 years old ~ 24 years old
    (2) 25 years old ~ 29 years old
    (3) 30 years old ~ 34 years old
    (4) 35 years old ~ 39 years old
    (5) 40 years old ~ 44 years old
    (6) 45 years old ~ 49 years old
    (7) 50 years old ~ 54 years old
    (8) 55 years old ~ 59 years old
    (9) 60 years old ~ 64 years old
    (10) more than 65 years old

61. Please select your final education.
    (1) Middle school graduate
    (2) High school graduate
    (3) 2-year associated degree
    (4) Bachelor's degree
    (5) Master's degree
    (6) Ph.D.

62. Please select your marital status.
    (1) Married
    (2) Unmarried

63. Please select the range of your annual salary.
    (1) Below KRW 10,000,000
    (2) More or equal to KRW 10,000,000 ~ below KRW 20,000,000
    (3) More or equal to KRW 20,000,000 ~ below KRW 30,000,000
    (4) More or equal to KRW 30,000,000 ~ below KRW 40,000,000
    (5) More or equal to KRW 40,000,000 ~ below KRW 50,000,000
    (6) More or equal to KRW 50,000,000 ~ below KRW 60,000,000
    (7) More or equal to KRW 60,000,000 ~ below KRW 70,000,000
    (8) More or equal to KRW 70,000,000

Thank you for participating this survey.

CHAPTER 3

FOSTERING CITIZEN-CENTERED LIVING LABS IN SOUTH KOREA: ANALYZING CITIZENS' PERCEPTIONS AND KEY INFLUENCING FACTORS

Chapter 3

Fostering Citizen-Centered Living Labs in South Korea: Analyzing Citizens' Perceptions and Key Influencing Factors

By

Jooyeol MAENG[3] Yooncheong CHO[4]

Abstract

The objective of this study is to offer insights for policy formulation and adjustments concerning living labs in Korea by examining citizens' perceptions of living labs and determining the factors influencing the activation of citizen-centered living labs. The study is structured into five parts to address the following questions:

1. How do citizens comprehend the definition and scope of living labs?
2. What is citizens' perception of the impact of living labs on society?
3. How do citizens view the growth of living labs in society?
4. What is citizens' perception of the role of local government in fostering sustainable living labs?
5. How do citizens perceive the future of living labs?

Through factor analysis, ANOVA, and multiple regression analysis of data collected through an online survey, the study identifies factors such as real-life conditions, locality, and environmental impact that influence citizens' attitudes and anticipated satisfaction towards living labs. This suggests that citizens prioritize living labs that focus on enhancing quality of life and addressing real-life conditions. Furthermore, the study reveals that factors like technical support, expert participation, and local government policy support impact citizens' overall attitude, anticipated satisfaction, and intention to participate in living labs. This underscores citizens' preference for technologically advanced living labs with expert validation and stable support from local government policies. Moreover, the study highlights the crucial role of local governments in informing and motivating citizens to actively engage in living labs

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by providing better public services, connecting living labs, and promoting their benefits. Additionally, factors such as user-centered growth of living labs, their impact on social interactions, and environmental contributions influence citizens' anticipated satisfaction. The findings suggest that citizens attribute significant importance to the environmental contributions of living labs for a sustainable society. Overall, the study offers policy and managerial implications for prioritizing citizens' attitudes, satisfaction, and participation intentions in living labs, emphasizing the need for appropriate policy preparations and adjustments to meet citizens' expectations and promote sustainable development.

Keywords: Living labs, Citizens' Perception, Quality of Life, Technical Support, Local Government, Promotion, Policy Amendment

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I. Introduction

The concept of smart cities has garnered significant attention in recent years as a means to address urban challenges and enhance citizens' quality of life through the integration of technology and innovation. Within this context, living labs have emerged as a promising approach for developing smart cities, providing a platform for collaboration and co-creation among various stakeholders including government, industry, academia, and citizens (Al-Nasrawi et al., 2015; Falco & Kleinhans, 2019).

The origins of the living labs concept can be traced back to 1990 when it was first explored to describe experimental work conducted by students in a large urban neighborhood of Philadelphia, Pennsylvania, aimed at addressing community challenges (Bajgier et al., 1991). Subsequently, Professor Mitchell of MIT introduced the living lab concept as a means to overcome the limitations of traditional laboratories by facilitating the observation and monitoring of interactions between users and IT devices (Mukama et al., 2022; Dutilleu et al., 2010; Mitchell, 2004). Over time, the concept of living labs has evolved into an approach for addressing complex social issues through the development, testing, and refinement of new technologies (Leal et al., 2023). Central to the living labs approach is the involvement of users as co-creators, placed on equal footing with other participants, and the experimentation in real-world settings (Almirall et al., 2012).

According to the European Network of Living Labs (ENoLL), living labs are characterized as user-centered, open innovation ecosystems that employ a systematic approach to user co-creation, integrating research and innovation processes within real-life communities and settings (Mukama et al., 2022). This definition aligns with other descriptions found in the literature, which also emphasize living labs as platforms for innovation where various stakeholders, including users, collaborate in real-world settings (Hossain et al., 2019). For example, Leminen et al. (2012) provide a similar definition, describing living labs as either physical regions or virtual environments where stakeholders, including firms, public agencies, universities, institutes, and users, come together in public-private-people partnerships, which collaborate in the creation, prototyping, validation, and testing of new technologies, services, products, and systems within real-life contexts.

The significance of living labs is increasingly recognized as they offer a platform where citizens can effectively respond to various situations, aiming to achieve a sustainable city through collaborative governance (Jang & Kim, 2019). In European cities like Helsinki and Barcelona, citizens are actively engaged in expressing their opinions on service development and play a crucial role in implementing highly sensitive services, a practice that is showcased in international

conferences (Jang & Lee, 2015). Living labs represent a shift in policy paradigm towards a bottom-up structure, where solutions are proposed by citizens and developed collaboratively. In Korean society, there is a growing trend towards seeking bottom-up solutions to urban and regional challenges or industrial revitalization, reflecting a maturing atmosphere of democratic decision-making (Han, 2016). In South Korea, leveraging advanced IT technology, successful living lab initiatives have been observed with active citizen participation, such as the Seongdaegol Energy Independent Village in Seoul and the Geonneoyu Project in Daejeon (Seong et al., 2016).

Despite the advancements in technological infrastructure like ICT, IoT, and AI, citizen participation in living labs in South Korea remains relatively low, and there is insufficient support for the commercialization of living labs and the dissemination of their outcomes (Park et al., 2019). Living labs often result in one-time projects or outcome-driven endeavors, leading to decreased civic awareness, diminished sense of purpose, and reduced connection with expert groups (Jang & Kim, 2019). Consequently, there is a need for better management and operational services that actively involve citizens to ensure the continuous development of living lab projects (Choi et al., 2020).

Shvetsova and Lee (2021) highlight that the early-stage development of living labs in South Korea is attributed to the gap between the innovation system and market regulation. They note that living labs in South Korea have primarily focused on experimental development processes through user participation, resulting in a lack of projects addressing real-life problems (Shvetsova & Lee, 2021). Additionally, Choo et al. (2023) argue that the misalignment of goals and expectations between citizens and local governments in South Korea acts as a barrier to the advancement of living labs. Thus, there is a consensus that clearer visions and goals are needed from living lab planners, along with improved inclusiveness of initiatives to encourage sustainable citizen engagement in the planning process and these factors are deemed essential for the active promotion of living labs in South Korea, which has not yet fully materialized despite policy promotion efforts (Choo et al., 2023).

The aim of this study is to explore citizen perceptions of living labs and identify strategies for improving management and public policies to establish sustainable citizen-centered living labs. While previous research has mainly focused on case studies and qualitative or exploratory approaches to classify different types of living labs, there is a notable gap in quantitative research, especially concerning citizen perspectives, participation, and policy considerations in the field of living labs. This study seeks to address this gap by conducting quantitative research to gain insights

into citizen perceptions and attitudes toward living labs, as well as their preferences for participation and policy priorities.

Therefore, this study begins by examining various definitions and the conceptual evolution of living labs in response to changes in societal trends and backgrounds. It investigates how living labs have evolved over time in response to citizen perceptions, technological advancements, and policy considerations. Furthermore, the study explores the factors influencing ongoing citizen-centered living labs, taking into account the widespread promotion of living labs in foreign countries and in South Korea, despite challenges such as low citizen participation and regulatory barriers. The research also sheds light on the policy implications and issues crucial for the development and establishment of living labs in society. It seeks to understand why citizen awareness and participation in living labs are relatively low in South Korea compared to other countries, despite advancements in ICT technology. Ultimately, the study aims to propose policy recommendations for revitalizing citizen-centered living labs by analyzing citizen perceptions of living labs in South Korea and identifying factors to enhance citizen awareness and participation in such initiatives.

In particular, this study examines the following: i) how do citizens understand the definition and scope of living labs? ii) how do citizens perceive the impact of living labs in the society? In particular, this study investigates how do factors such as policies promoting living labs, association with expert groups, technical support, and local government's support affect the overall attitude toward living labs and how the overall attitude affects citizens' satisfaction and intention to participate in living labs. iii) how do citizens perceive the growth of living labs in the society? In particular, this study examines how do factors such as policies promoting living labs, association with expert groups, technical support, and local government's support affect the overall attitude toward living labs? iv) how do citizens perceive the role of local government for the sustainability of living labs? and v) how do citizens perceive the prospect of living labs? The anticipated results of this study are expected to yield valuable managerial and policy implications, particularly concerning citizen relationship management.

II. Literature Review

2.1. Definition of Living Lab

While the general concept of living labs may be similar across countries, the specific models

pursued can vary greatly depending on local socio-economic conditions. There are multiple definitions of living labs, but they all share the fundamental idea of using real-world environments as experimental spaces for innovation and problem-solving. Living labs essentially turn everyday life into a laboratory, offering an innovative approach to addressing urban and community challenges by utilizing every aspect of the environment as a testing ground (Choi, 2022).

The European Network of Living Labs (ENoLL) defines living labs as open innovation environments situated in real-life settings, where user-driven innovation drives the collaborative creation of new services, products, and societal infrastructures. Living labs encompass societal and technological dimensions simultaneously in a business-citizens-government-academia partnership (Bergvall & Stahlbrost, 2009). Følstad (2008) also addresses the definition of living labs as an experiment and demonstration method in which citizens as users and companies as producers jointly create innovations in real-life setting. Ballon et al. (2005) defines living labs as an experimentation environment in which technology is given shape in real life contexts and in which end-users are considered 'co-producers'. In the same vein, Schaffers et al. (2007) defines living labs as: Living labs are user-centric environments for open innovation characterized by early and continuous involvement of users and by user-driven rapid prototyping cycles. Living labs are defined as a research and development methodology in which innovations are co-created and verified in various contexts and empirical real environments (Feurstein et al., 2008). Almirall and Wareham (2011) introduce living labs as an innovative research model that integrates both user-centered research and open innovation. Karlsson (2013) defines living labs are a forum for innovation that integrates the residents and other stakeholders to develop and test new ideas, systems and solutions in complex and real contexts. Leminen et al. (2012) define living labs as physical regions or virtual realities in which stakeholders form public-private-people partnerships of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts. With same context, Schuurman (2015) addresses the definition of living labs as living labs as an organized approach (as opposed to an ad hoc approach) to innovation consisting of real-life experimentation and active user involvement by means of different methods involving multiple stakeholders, as is implied in the Public-Private-People character of Living Labs. In particular, Steen and Van Buren (2017) defines living labs by combining cities and living labs as a variety of local experimental projects with participatory nature to find solutions to increase the sustainability of the city.

Since the emergence of living labs, numerous definitions have arisen, but they commonly

characterize living labs as experimental platforms or methodologies aimed at addressing social issues through user-centered collaborative innovation involving various stakeholders. This approach is typically directed towards fostering sustainable local communities or cities. Examining the concepts of living labs discussed above, living labs have been defined as an environment (ENoLL; Ballon et al., 2005; Schaffers et al., 2007), as a methodology (Følstad, 2008; Feurstein et al., 2008; Almirall & Wareham, 2011), and as a system (Leminen et al., 2012; Karlsson, 2013; Schuurman, 2015). The definitions of these three living labs are viewed not as contradictory to each other, but as complementary perspectives (Bergvall & Stahlbrost, 2009). Since this broad use of the concept of living labs, the increasing interest in living labs perceived as assets to achieve the Sustainable Development Goals (SDGs) (United Nations General Assembly, 2015) has been increasing consistently, through the years (Leal et al., 2023).

Table 1. Definition of Living Lab by 3 Types

Type	Researcher	Definition
Environment	ENoLL	An open innovation environment in a real life setting in which user-driven innovation is the co-creation process for new services, products, and societal infrastructures
	Ballon et al. (2005)	An experimentation environment in which technology is given shape in real life contexts and in which end-users are considered 'co-producers'
	Schaffers et al. (2007)	User-centric environments for open innovation characterized by early and continuous involvement of users and by user-driven rapid prototyping cycles
Methodology	Følstad (2008)	An experiment and demonstration method in which citizens as users and companies as producers jointly create innovations in real-life setting
	Feurstein et al. (2008)	A research and development methodology in which innovations are co-created and verified in various contexts and empirical real environments
	Almirall & Wareham (2011)	An innovative research model that integrates both user-centered research and open innovation
System (Organized Approach)	Leminen et al. (2012)	Physical regions or virtual realities in which stakeholders form public-private-people partnerships of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products, and systems in real-life contexts
	Schuurman (2015)	An organized approach (as opposed to an ad hoc approach) to innovation consisting of real-life experimentation and active user involvement by means of different methods involving multiple stakeholders, as is implied in the Public-Private-People character of Living Labs
	Karlsson (2013)	A forum for innovation that integrates the residents and other stakeholders to develop and test new ideas, systems and solutions in complex and real contexts.

Various studies have outlined the scope of living labs. Leminen et al. (2012) categorized

living labs into four types based on leading actors: utility-driven, led by private companies for product and service system development; enabler-driven, led by local government or the public sector; provider-driven, led by a university or research institute; and user-driven, led by citizens and grassroots organizations. Mulder et al. (2008) highlighted several characteristics of living labs, including users' involvement, service creation, infrastructure, governance, innovation outcomes, and methodological tools supporting new technologies. Steen and Van Buren (2017) underscored innovation, formal learning, development, co-creation, iteration, decision-making power for all participants, and real-life contextual use as key features of living labs. Additionally, the European Network of Living Labs (ENoLL) outlined the components of living labs, including active user involvement, real-life settings, multi-stakeholder participation, a multi-method approach, and co-creation (Ruijsink & Smith, 2013).

Two main scopes of living labs are highlighted: participation and the context of innovations. Participation of all stakeholders, including potential customers along the value chain, is crucial for successful living lab operation (Feurstein et al., 2008). Therefore, garnering public attention to living labs is essential for sustained systematic innovation operations, with citizens and related institutions directly involved in their operation (Niitamo et al., 2006). Unlike traditional empirical social science research, which often involves low-level observation, and lab experimentation, which typically occurs in single, controlled contexts, living lab experiments aim for the same level of observation in an organic, multi-contextual space (Eriksson et al., 2005). This implies that customers participating in living labs are observed across various aspects of their lives, including their roles as citizens, workers, at home, and during travel (Feurstein et al., 2008).

2.2. Development of Living Lab

2.2.1. Development of Living Lab in Foreign Countries

As scholarly research on living labs gained momentum around 2010, they emerged as a new strategy to stimulate innovation opportunities in education for sustainability (Leal et al., 2023). Initially, living labs were experimental activities conducted by university students to address community challenges. In the 1990s, Prof. Mitchell further developed the concept of living labs by focusing on developing, testing, and refining new technologies (Mitchell, 2004). Universities still hold significant potential to support the implementation of the Sustainable Development Goals (SDGs) through living labs and by collaborating with students, workers, stakeholders, and the

broader community, universities can pursue innovative solutions that offer economic, social, and environmental benefits for both the university and the community (Purcell et al., 2019). This interaction creates opportunities to enhance knowledge in sustainability through participatory research (Daneri et al., 2015). Consequently, living labs serve as a potent learning and action tool to engage students in projects organized at the community level while facilitating collaboration among stakeholders with diverse areas of expertise (Purcell et al., 2019).

Since the establishment of ENoLL in 2006, the global living lab movement has gained momentum, showcasing practical aspects through integrated research and innovation processes in actual community settings (Hossain et al., 2019). Scholars have delved into defining the core values of living labs, highlighting specific values like "real-life," "user participation," and "interaction spaces in collaboration with stakeholders" (Leminen, 2013). With an emphasis on core values such as innovation and co-creation, there has been a shift towards meeting the needs of both production and actual users, rather than merely serving as testing grounds (Steen & Van Bueren, 2017). Research on living labs has evolved to encompass how to design and manage them effectively, as well as how to engage with stakeholders and apply them in various contexts (Leminen et al., 2015). Living labs such as Amsterdam's Smart Citizen Kit, Coventry's CovJam, and Helsinki's Smart City Living Lab serve as open data repositories that reflect citizens' opinions and inform public policies. These living labs have been developed to empower residents to spearhead projects necessary for building sustainable communities and generate tangible results.

Feurstein et al. (2008) highlight a core advantage of the living labs concept over traditional methodologies: its multi-contextual nature, wherein innovative services are offered and adopting a networking approach to living labs, beyond individual implementations, can significantly extend this sphere. This networked living labs approach offers developers immediate feedback on the potential acceptance of products in specific communities and regional settings, thus averting duplicative investments in infrastructure and technology (Feurstein et al., 2008). Furthermore, it is noted that regional, national, or continent-wide networks of living labs can enhance opportunities to integrate social innovations with technological innovations on a broader scale, contributing to socio-economic dynamism and such networks of living labs are envisioned as large-scale experimental platforms for creating new services, businesses, technologies, and even markets and industries within the ICT sector (Niitamo et al., 2006).

While living labs have garnered growing attention in both theoretical discourse and practical implementation, users have not yet reached the anticipated level of co-creation, remaining passive

rather than taking an active role in the innovation process (Greve et al., 2017; Nyström et al., 2014). Further studies are required to uncover the reasons for this gap and to identify policy support measures that can help bridge it.

2.2.2. Development of Living Lab in South Korea

As the active utilization of living labs as a form of social innovation becomes increasingly vital for addressing local community issues, research on living lab models based on citizen participation is gaining momentum. In South Korea, which lags behind Europe by more than a decade, where approximately 20 living labs united to establish the European Network of Living Labs (ENoLL) in 2006, the concept was initially introduced as a means of technological or industrial innovation by the Ministry of Trade, Industry and Energy and the Ministry of Science and ICT (Yoon, 2018). Regarding the diagnosis and evaluation of living labs in South Korea, their significant recent proliferation, especially within local governments, for various purposes ranging from civil complaint resolution initiatives to technology innovation-driven business model creation projects, can be seen as a positive expansion of the foundation for regional innovation (Lim, 2016). However, despite the growing presence of living labs in South Korea, concerns have been raised about their transient nature and failure to establish a sustainable living lab platform akin to the active ones in Europe (Seong & Lee, 2018). To foster the establishment of enduring living labs rather than one-time projects, it is crucial to sustain active participation and communication among stakeholders throughout the entire process, particularly, there is an emphasis on the need for local governments to proactively enhance awareness and develop more systematic policies that consistently validate citizens' perceptions of services related to living labs (Choi et al., 2020).

Despite numerous efforts, such as policy promotion and financial support through living lab competitions sponsored by both central and local governments, the advancement of sustainable citizen-centered living labs in South Korea is still perceived to be at the experimental stage (Shvetsova & Lee, 2021). According to Hubavem (2019), establishing an interactive network involving the government, market, and private sector is essential for the continuous development and management of living labs, which offer clear advantages, however, in South Korea, breaking free from decades-old regulatory entanglements within the industrial market remains a challenge. Therefore, Shevetsova and Lee (2021) emphasize the importance of leveraging end users' experiences and creativity, so they suggest that, as a country that has achieved economic development through an innovation-driven strategy, South Korea should adopt a new innovation

strategy rooted in the perspectives of end users, particularly within policy-driven living labs.

Lim (2016) contends that due to the diverse nature of living labs in terms of concept definition, application cases, and performance evaluation, there is a simultaneous need for systematic research and practical application to inform policy development while continuous evaluation, facilitated by feedback from public officials, citizens, and expert groups, is deemed essential. Additionally, there is an urgent call for policies that can establish cooperation and management systems by networking various local living labs within the broader framework of social innovation (Lim, 2016). This necessity extends to the development of citizen-led living labs through collaboration within inter-city living lab networks, primarily active in Europe (Bae & Shin, 2019). To sustain the development of citizen-led living labs, akin to European models, clear directives from central and local governments regarding purpose, key elements, principles, and achievements are imperative, furthermore, there is an urgent need to establish a policy framework capable of evaluating and diagnosing implemented projects (Lim, 2016).

In conclusion, the advancement of living labs in South Korea necessitates continuous policy support aimed at loosening market regulations and fostering a platform conducive to active engagement in innovative endeavors. This entails collaboration among local governments, private companies, and citizens, supported by thorough diagnosis and evaluation of ongoing and planned living lab projects. Such initiatives can pave the way for sustainable innovation and societal advancement in the Korean context.

2.3. Applications of Living Lab

Indeed, despite challenges such as low citizen participation, limited stakeholder co-creation, and inadequate policy support, living labs in cities across the world's leading countries are demonstrating successful promotion and impactful outcomes in addressing social and economic challenges through innovative means. Literature extensively discusses and evaluates these living lab cases, highlighting their diverse and life-centered nature. As experimental models geared towards solving social problems through user-centered innovation and stakeholder collaboration, living labs offer a wide array of examples from leading living lab countries worldwide.

The Smart Citizen Kit developed in Amsterdam addresses citizens' concerns about air quality by allowing them to collect data on various environmental factors such as temperature, humidity, noise level, and light intensity in their daily lives (Amsterdamsmartcity, 2016). This collaborative project, conducted with the research foundation Waag (2014) and the Amsterdam

Economic Board, enables citizens to share the collected data online, facilitating comparisons with other regions (Amsterdamsmartcity, 2016). Praised for its success, the project has garnered positive reviews, with Tomas Diez, Founder of the Smart Citizen Kit, describing it as empowering people to reclaim their city (Nesta, 2023).

CovJam exemplifies a structure where university researchers initiate research on the design and redesign of specific public services, with subsequent involvement of public officials as team members, and citizens as end users providing feedback on the service (Waart et al., 2016). This online venture, presented by Coventry City and IBM, utilized social media as part of a three-day brainstorming event focused on the city, particularly, social media platforms facilitated government programs in conducting surveys and refining services, ultimately encouraging greater public participation (Burton, 2013). CovJam underscores the efficiency of citizen-participating living labs and highlights the role of both companies and governments in fostering active citizen engagement.

The Helsinki Smart City Living Lab in Finland prioritizes democratic decision-making, with relevant stakeholders participating in the establishment of long-term urban planning initiatives on a citywide scale (Fiksukalasatama). Operated through Forum Virium Helsinki (FVH) and guided by the goal of "Giving citizens back an hour a day," this innovation living lab for urban planning fosters close partnerships among the city, businesses, and residents (Helsinki Region Infoshare). Through this user-centered collaborative living lab, 16 projects addressing urban challenges such as smart waste management, intelligent parking solutions, health and wellness initiatives, shared libraries, and communal playgrounds have been implemented (Helsinki Region Infoshare). These public amenities in the new city are utilized by Kalasatama residents, who have the opportunity to share innovative ideas and voice opinions through various channels including online platforms and the Innovation's Club, involving stakeholders such as the city government, development firms, residents, civic organizations, and research institutes (Park et al., 2019). This living lab represents a Northern European-style direct democracy experiment, emphasizing close cooperation among city authorities, developers, residents, and civic groups while pioneering a smart city model that explores diverse technologies and concepts (Seong & Lee, 2018).

The Ma Village living lab in Vietnam is dedicated to testing climate-smart agricultural practices in collaboration with local farmers. Through iterative experimentation conducted directly with farmers, the lab aims to develop resilient and sustainable farming methods tailored to the village's unique climate challenges. As a result of these user-centered experiments, Ma Village has

been able to identify cultivation techniques that are well-suited to its soil and climate conditions, particularly in response to climate change and by leveraging the data and insights gathered from these experiments, the local government has been able to provide targeted policy and financial support to further support sustainable agriculture in the region (CIAT, 2016). This case highlights the voluntary and proactive participation of residents in living labs, particularly in the pursuit of sustainable economic livelihoods, and underscores the potential for locally-driven solutions to address pressing challenges such as climate change adaptation in agriculture.

Table 2. Characteristics and Types of Living Lab Cases in Foreign Countries

	Smart Citizen Kit	CovJam	Helsinki Living Lab	Vietnam's Ma Village
Purpose of Business Promotion	Discovery and execution of projects according to the needs of citizens	Online meetings that design specific public services	Various experiments for transition to smart city development	Development of innovative agricultural technology
Participants	Citizens Businesses Local government	Citizens Businesses (IBM) University researcher Politicians Local government	Residents Businesses Research institutes Local government	Farmers Businesses Research institutes Local government
Main Activity	Collecting and sharing information related to energy, environment, and civic life	Massive discussions and applications related to education, commerce, environment and transport in Coventry	Smart city design, operation, and infrastructure construction through innovative idea discourse	Innovative experiments to improve agricultural resilience and sustainability in preparation for climate change
Characteristic	Citizen participation platform based on living lab through experiment and demonstration	Citizen participation platform based on living lab through on & offline meeting	Reflecting the needs of residents at the urban planning stage in a democratic way	Residents' voluntary living lab on climate-related economic issues

Sources: Amsterdamsmartcity, 2016; Burton, 2013; Waart et al., 2016; Fiksukalasatama (https://fiksukalasatama.fi/); Helsinki Region Infoshare (https://hri.fi/en); CIAT, 2016

In South Korea, despite various challenges facing living labs, notable examples of citizen participation include the Geonneoyu project in Daejeon, where citizens identified local issues and developed a smartphone app to monitor river flooding during heavy rainfall. Another example is the energy self-sufficiency initiative of residents in Seoul's Seongdaegol area, who implemented energy-saving measures through their own solar power business. Additionally, Seoul has launched the Metaverse Seoul project, the world's first public Metaverse platform aimed at integrating citizen input and reflecting citywide policies (Seoul City, 2023). Furthermore, Hanam City has developed the Hanam e Self platform, a digital village living lab that enables citizen participation in identifying

and addressing local challenges (Hanam City Living Lab, 2020). These initiatives highlight the growing importance of citizen involvement in addressing urban and community issues through innovative living lab approaches.

As citizens became more willing to address practical social issues and gained access to ICT, a trend emerged where individuals could easily share opinions and information (Seong et al., 2016). In response to this trend, citizens in Daejeon initiated a living lab experiment to address their own concerns by developing a web service for real-time river flooding monitoring (Hwang, 2015). The initiative was prompted by frequent accidents during heavy rain near the Fish Bridge in Yuseong, Daejeon, leading to the promotion of the Geonneoyu project as a living lab to address safety issues at the bridge (Seong et al., 2016). Residents and university students in the vicinity of the Fish Bridge participated in workshops to brainstorm ideas, introducing the concept of the "Living Lab" as a means to tackle everyday challenges directly experienced by citizens, defining local issues and exploring potential solutions (Hwang, 2015). The Geonneoyu Project exemplifies a bottom-up problem-solving approach led by civil society, where villagers and communities collaboratively identify problems and propose solutions to local governments as an empirical demonstration of how anyone can participate in problem-solving through living labs, such as the Geonneoyu project, leveraging ICT (Seong et al., 2016).

Seongdaegol stands out as a notable case where community governance was established through an energy living lab driven by resident participation. According to "The Living Lab for Micro Solar Power in Urban Community" report (Kim et al., 2017), the Seongdaegol energy-independent village community, located in Sangdo 3-dong, Dongjak-gu, Seoul, comprises 50 households and 34 members of the cooperative 'Maeuldassallim', actively engaged in energy-related activities and communication. Situated in a densely populated area with over 13,000 households and a high tenant ratio of 58.2%, Sangdo 3-dong faces challenges such as aging buildings constructed mainly in the 1970s and 1980s (Kim et al., 2017). Following the Fukushima nuclear power plant accident in 2011, residents of Seongdaegol became increasingly interested in energy issues for sustainable community development and with support from the Happiness-Centered Fund and collaboration with the Green Alliance, residents attended sustainable energy lectures and workshops under the 'My Neighborhood Green Academy' program, setting the goal of establishing an energy-independent village (Seong et al., 2016). Over three to four years of energy education, a living lab was introduced in 2015 to experiment with sustainable energy system conversion, with a particular focus on a mini solar power project (Kim et al., 2017). Initially, the

living lab prioritized educating village researchers and conducting workshops on solar power generation technology to raise awareness and acceptance among residents, subsequently, in collaboration with Seoul City, Dongjak-gu, energy innovation companies, and research institutes, the Seongdaegol living lab advanced a more refined mini-solar panel project for home installation, incorporating user feedback and data (Seong et al., 2016). The Seongdaegol case is noteworthy for its pioneering collaboration among research institutes, universities, corporations, financial institutions, and local governments through a citizen-led energy living lab, serving as a model for community governance in South Korea (Lee, 2016).

Among the applications of living labs, the Seoul Metropolitan Government has leveraged advanced technology, particularly Metaverse, to enhance citizens' quality of life in the online environment. By providing better information, services, and developing policies for citizen relationship management, the government aims to improve the overall citizen experience. According to the Seoul Metropolitan Government (Seoul City, 2023), it introduced the world's first public Metaverse platform, 'Metaverse Seoul,' at the Multipurpose Hall of Seoul City Hall as an initiative of the Metaverse Seoul Basic Plan established in 2021, offering administrative services across five key areas: economy, education, tax, administration, and communication. Through the Metaverse Seoul platform, the city plans to incorporate various public services, creating a virtual space characterized by the core values of creation and communication, surrealism without discrimination, and convergence with freedom, companionship, and connection, for instance, participants, represented as avatars, can freely interact within the virtual Mayor's Office, where they can exchange greetings with Mayor Oh Se-hoon and provide feedback on city administration through an opinion suggestion box(Seoul City, 2023). This innovative approach allows citizens to engage with city services and officials regardless of their physical location, age, or circumstances in reality.

According to Hanam City Living Lab (2020), Hanam e Self, promoted by Hanam City, is a digital village living lab platform designed to identify and address village-related issues through collaborative problem-solving. It comprises various components, including a village resource map, village agenda, living lab, village community, and residents' council, enabling residents to raise and resolve a wide range of civil complaints. The platform aims to enhance existing resident participation projects and foster community initiative, responsibility, locality, and experimentation. Many residents actively engage with the platform by contributing to actual village agendas and recent examples include addressing residents' complaints, ranging from requests for toilet

installation on Deokpung Trail to mitigating risk factors at the entrance to Mangwol-dong Tree Orphanage (Hanam City Living Lab, 2020).

Table 3. Characteristics and Types of Living Lab Cases in South Korea

	Geonneoyu project	Seongdaegol Living Lab	Metaverse Seoul	Hanam e-Self
Purpose of Business Promotion	Prevention of disasters caused by frequent flooding of rivers according to the needs of citizens	Solar power business for energy independence according to residents' needs	Online public opinion expression service for citizen convenience policies such as education, welfare, entrepreneurship, and civil complaints in Seoul	Online public policy development service for city policies such as education, welfare, etc. in Hanam city through citizen participation
Participants	Citizens Businesses University researcher Local activists Local government	Residents Businesses University researcher Local activists financial institutions Local government	Citizens Businesses Local government	Citizens Judging committee Local government
Main Activity	Experiments and verification based on real life data Development of innovative apps	Experiments and verification based on real life data Development of innovative devices (Custom solar panels)	Develop user-oriented Metaverse Seoul website and policies based on data	Citizen Policy Proposal Convergence Expert Group Verification of Feasibility
Characteristic	Develop practical apps through living labs data according to citizen needs	Sustainable living lab through collaboration between citizen and community expert groups and local governments	Metaverse-type online living lab platform that enhances convenience and participation of citizens	Citizen participation platform based on living lab through on & offline meeting

Sources: Hwang, 2015; Kim et al., 2017; Seong et al., 2016; Seoul City, 2023; Hanam City Living Lab, 2020

2.4. Living Lab and Public Policy

2.4.1. Necessity of Policy Preparation for Living Labs

Living labs are gaining prominence as a viable approach for addressing not only local community issues but also the urban development needs of citizens in a more innovative manner. Consequently, many countries and cities worldwide are rushing to develop policies to support living labs. Reflecting on the origins of living labs discussed in the previous chapter, they have emerged as a fresh strategy to foster innovation opportunities in education for sustainability within universities (Leal et al., 2023). Initially, living labs were experimental endeavors undertaken by university students to assist local communities with their challenges and today, universities remain

pivotal in seeking novel solutions that offer economic, social, and environmental benefits for themselves and their communities by collaborating with students, businesses, and various stakeholders (Purcell et al., 2019).

As discussed in the previous chapter, the primary focuses of living labs are the participation of citizens as end users and the innovation context. Particularly, it has been underscored that the involvement of not only citizens but also stakeholders related to the issues is crucial for the effective operation of living labs (Feurstein et al., 2008). Nam and Prado (2011) have argued that the sustainability of living labs hinges on participatory governance, positing that cities achieve smart status when investments in human-social capital and ICT infrastructure drive sustainable growth and enhance quality of life through citizen governance policies. However, fundamentally, living labs require long-term funding to maintain and expand innovation activities, and many of them become heavily reliant on public funding, constraining their growth and innovation endeavors (Evans et al., 2015). This situation falls short of the co-creation and innovation initially anticipated, as the intended objectives are expected to emerge based on the outcomes achieved through living lab activities among stakeholders (Hossain et al., 2019). Therefore, as Niitamo et al. (2006) asserted, the policies of local governments that draw public attention and involvement from relevant institutions to living labs for long-term systematic innovation activities, beyond mere financial support, have become imperative. This necessity is further underscored by examples from cities like Amsterdam, Coventry, Helsinki, and Seoul, which are implementing various policies to encourage direct citizen participation in living labs.

Policies concerning the collaboration of diverse stakeholders and sustainability, which are fundamental attributes of living labs, frequently come to the forefront. Sustainability has emerged as a global imperative, particularly in the face of climate change and economic instability, making sustainable development a pressing concern worldwide. It is posited that user engagement can be heightened when living labs address sustainability challenges, and the sustainability of living labs is bolstered when a collaborative network fosters creativity and innovation (Bergvall-Kareborn et al., 2009; Buhl et al., 2017). Living labs offer an environment that encourages various actors to contribute to sustainable development. Indeed, European nations like Spain and the Netherlands are spearheading policy shifts that prioritize transportation, energy, and environmental issues through citizen participation, expanding citizen engagement, enhancing regulatory frameworks for innovation, streamlining decision-making processes by integrating government departments, and advocating for openness, standardization, and financial security measures (Choi, 2022).

2.4.2. Policy Issues for Living Labs in South Korea

Since 2010, South Korea has witnessed a surge in interest in smart cities, accompanied by discussions on policy limitations. Smart city initiatives, primarily focusing on technology-driven infrastructure development through a top-down approach led by the central and local governments, have faced criticism (Cho et al., 2018). In 2018, the 4th Industrial Revolution Committee underscored that smart cities are shaped by people, not just technology. In line with this perspective, both central and local governments have been implementing policies to introduce living labs as platforms for citizen-centric service provision and innovation (Choi, 2022). More recently, there has been a concerted effort by these authorities to promote living lab projects aimed at addressing social issues closely intertwined with people's daily lives, including safety, welfare, and aging, with the goal of leveraging advanced technology to tackle these challenges.

As citizens increasingly take on primary roles in addressing social issues and the importance of civil society in digital social innovation gains recognition, The Ministry of Science and ICT and the Ministry of the Interior and Safety have launched the '2019 Digital Social Innovation Project'. This initiative aims to broaden opportunities for public participation and foster community-based collaborative governance (Bae & Shin, 2019). Despite the evident successes of living labs in various cities supported by policies, criticisms of living labs persist, particularly regarding low citizen engagement. To establish a genuinely citizen-centered and sustainable urban environment, comprehensive policies that should outline the processes and operational plans of citizen-led living labs, rather than merely focusing on citizen participation for administrative purposes (Kim & Lim, 2020).

In the cases of Amsterdam and Copenhagen living labs, local governments have demonstrated leadership by establishing mid- to long-term visions and plans, providing active funding, and creating venues for connection and cooperation among relevant stakeholders to address issues (Seong & Lee, 2018). As highlighted in various literature, it's imperative for South Korean local governments to develop policies aimed at transforming the overall social innovation system with a long-term perspective toward establishing a sustainable socio-technical system, moving beyond one-time projects (Shvetsova & Lee, 2021). Similarly, Lim (2016) and Seong and Lee (2018) advocate for living labs to begin easily through various innovation activities and policies should focus on enhancing social acceptance of innovation through continuous feedback from developers and technology users, along with various educational experience promotion activities. Drawing

insights from successful living labs in Europe, it's crucial to establish various communication channels to ensure ongoing interaction and feedback between the public and private sectors throughout the problem definition, alternative development, and evaluation processes and policies should encourage active participation from citizens, who are the true subjects of everyday life, on a regional basis (Choi et al., 2020).

Regarding the role of local governments in citizen-centered living lab policies, there's a pressing need to shift the policy paradigm from the existing focus on technological infrastructure to one centered around people and services, and this shift also involves moving away from government- and expert-centered approaches towards ones that are led by local citizens including establishing venues for cooperation with relevant entities, managing and operating related facilities, establishing legal foundations, and enhancing evaluation systems (Seong & Lee, 2018). Additionally, local governments should actively seek out social innovation organizations and foster collaboration between public, organized user groups to be able to interact with online and offline knowledge providers, fostering active citizen participation within a network platform supported by responsible ministries, ensuring consistency and integration across initiatives (Lim, 2016; Seong & Lee, 2018; Hubavem, 2019; Shvetsova & Lee, 2021).

The studies reviewed thus far have shed light on various aspects of living labs, including their definition, development process, classification, case studies, and policy proposals aimed at enhancing citizen-centered living labs. While living labs offer an innovative approach to problem-solving through collaboration among stakeholders, including citizens, there remains a gap in research regarding practical issues such as low citizen awareness and participation, as well as outdated policies that affect their effective operation.

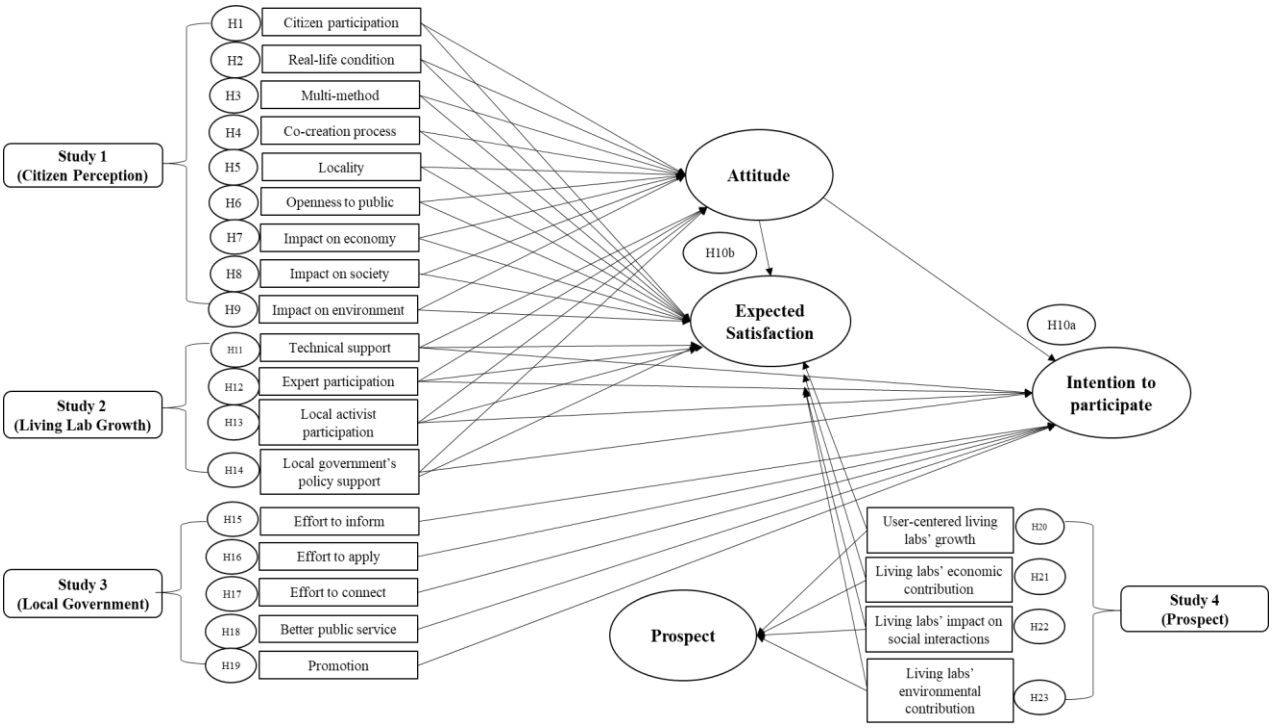
In contrast to overseas cities like Helsinki and Barcelona, where citizens actively engage in service development and play a central role in realizing tangible outcomes, South Korea, as a newcomer to the living lab methodology, faces challenges in refining policies related to operational procedures and standards. There is also a need to restructure local government policies to promote citizen awareness and foster diverse network platforms.

With this context in mind, this study aims to contribute insights that can inform policy improvements and amendments, ultimately enhancing citizen perceptions and satisfaction regarding their role as integral participants in the living lab process.

III. Hypotheses Development

The hypotheses of this study were basically derived from four studies. Study 1 examines how each of the nine variables influences citizens' attitudes and their expected satisfaction with living labs. Study 1 also investigates how overall attitudes impact the intention to participate in living labs and expected satisfaction. Study 2 assesses how each of the four variables affects citizens' perceptions, including attitudes and expected satisfaction, regarding the growth of living labs and their intention to participate. Study 3 focuses on five variables and their impact on citizens' awareness of the role of local government in sustainable living labs, as well as their intention to participate in such initiatives. Finally, Study 4 examines the effects of four variables on citizens' expected satisfaction and prospects for living labs. These studies collectively aim to provide insights into the factors influencing citizens' attitudes, perceptions, awareness, intention to participate, and expected satisfaction regarding living labs, thereby informing policymaking and decision-making in this area.

Figure 1. The Logic Model of Hypothesized Variables in Studies 1, 2, 3, & 4



Note: This figure is an integration of the multiple regressions that are modeled and analyzed in this study.

3.1. Study 1: How Do Citizens Perceive the Impact of Living Labs in the Society?

This study aims to explore the factors that promote living labs and their impact on citizens' attitudes, expected satisfaction, and intention to participate. The proposed factors include citizen participation, real-life conditions, multi-method approach, co-creation processes, locality, openness to the public, and the impacts on the economy, society, and environment. Hypothesis testing will investigate the influence of these factors on citizens' attitudes toward living labs, as well as how attitudes affect expected satisfaction and the likelihood of participation. Additionally, insights gained from policy recommendations are expected to inform policy implications and enhance citizens' intention to participate in living labs.

3.1.1. Effects of Citizen Participation on Overall Attitude and Expected Satisfaction

Citizen participation stands as a crucial element in the functionality and revitalization of living labs, a sentiment echoed across various definitions and policies associated with these initiatives in numerous cities. Adopting a user innovation approach, scholars like Leminen (2013) and Almirall et al. (2012) portray living labs as a bottom-up methodology, where users or communities, acting as co-creators, address their needs through active involvement. The pivotal role of user engagement, particularly as citizens, is underscored in living labs, with citizens and civil society being recognized as not only sources of innovation but also essential participants in innovation endeavors (Mulder et al., 2008; Leminen et al., 2015; Eriksson et al., 2005). Moreover, living labs serve to cultivate new products and services by harnessing the diverse knowledge, ideas, and experiences of engaged users (Hielkema & Hongisto, 2013). While several cities have endeavored to develop policies, platforms, and incentives to encourage ongoing citizen participation in living labs, the prevailing sentiment suggests that citizen involvement, despite being a focal point, remains inadequately realized in many instances, barring a few cities with notably active citizen participation such as Barcelona, Helsinki, and Amsterdam. Encouraging more citizens to participate in living labs is both important and challenging from a policy perspective. However, as seen in successful cases, citizen participation can create a positive feedback loop: increased participation raises awareness of living labs, which in turn attracts more citizens to get involved. This paradoxical effect underscores the importance of initial engagement strategies and sustained efforts to maintain and grow citizen involvement. Therefore, this study hypothesized the effects of citizen participation factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H1a: Perceived citizen participation in living labs affects citizens' overall attitude.
H1b: Perceived citizen participation in living labs affects citizens' expected satisfaction.

3.1.2. Effects of Real-life Condition on Overall Attitude and Expected Satisfaction

The factor of real-life setting in living labs holds significant meaning for citizens' overall attitudes toward these initiatives, particularly in addressing real-world problems. Unlike traditional research settings, the emphasis on real-life environments within living labs is considered pivotal for fostering innovation, offering contextual insights based on user experiences, and promoting openness (Schuurman et al., 2014). Consequently, living labs have expanded the scope of real-life environments from singular, isolated locations to encompass educational institutions, people's homes and workplaces, and various urban settings (Nyström et al., 2014). Examples like the Seongdaegol Energy Living Lab and the Geonneoyu Project illustrate the sustainability of living labs that engage with real issues within authentic life settings. Such demonstrations underscore the importance of addressing problems closely tied to citizens' lives within living labs. In other words, the real-life condition is a more advanced, user-centered setting that recognizes the limitations of existing research, which has mainly been confined to research labs. This approach allows citizens to conduct experiments based on their own real-life experiences and receive realistic feedback on the results. This shift towards incorporating real-life conditions ensures that the findings and innovations from living labs are more relevant and applicable to everyday situations, ultimately leading to more meaningful and impactful solutions for urban living. Therefore, living labs that are situated in real-life contexts have the potential to significantly influence citizens' overall attitudes and expected satisfaction toward these initiatives. Therefore, this study hypothesized the effects of real-life condition factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:
H2a: Perceived real-life condition for living labs affects citizens' overall attitude.
H2b: Perceived real-life condition for living labs affects citizens' expected satisfaction.

3.1.3. Effects of Multi-method on Overall Attitude and Expected Satisfaction

The multi-method approach within living labs is perceived to exert an influence on citizens' overall attitudes toward these initiatives by offering an innovative alternative to conventional research methods. Living labs adopt a methodology that spans various stages of the innovation development process, including exploration, experimentation, and evaluation, so throughout these

stages, innovation progresses from initial ideation to conceptualization, leveraging new user-driven data facilitated by advanced technology, and ultimately culminating in the testing and benchmarking of prototypes (Malmberg et al., 2017).

ENoLL has highlighted the multi-method approach as a defining feature of living labs, wherein diverse users employ and adapt various methodologies suited to their specific objectives, without adhering to rigid, predefined structures (Ruijsink & Smith, 2013). Living labs are characterized by an environment of openness and equality, allowing all participants to freely express their ideas and opinions, unfettered by formal constraints beyond the existing framework. This flexible and inclusive approach fosters a collaborative atmosphere conducive to innovation within living labs. In other words, this means that the problem-solving method carried out within the living lab is not predetermined, allowing for various innovative problem-solving approaches. This flexibility is made possible as various stakeholders and experts freely participate, bringing diverse perspectives and expertise to address the issues at hand. Such an open and collaborative environment encourages creativity and the development of tailored solutions that are more effective and responsive to the unique challenges faced by the community. Therefore, this study hypothesized the effects of multi-method factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H3a: Perceived multi-method in living labs affects citizens' overall attitude.

H3b: Perceived multi-method in living labs affects citizens' expected satisfaction.

3.1.4. Effects of Co-creation Process on Overall Attitude and Expected Satisfaction

The co-creation process within living labs is perceived to exert an influence on citizens' overall attitudes toward these initiatives, as it involves collaborative creation between experts in various fields and diverse stakeholders deliberating on problems and solutions. At its core, living labs operate on the principle of open innovation, relying on external sources for innovation through co-creation with a multitude of stakeholders, so by fostering collaboration, living labs facilitate the development and validation of new products and services (Bergvall-Kåreborn et al., 2009; Veeckman & Temmerman, 2021). Schuuman et al. (2014) underscores the significance of co-creation, defining living labs as a form of innovation that places users at the forefront and champions co-creation. From its inception, ENoLL advocated for the active participation of both producers and users in the process through interactive engagement and bottom-up experimentation, emphasizing that users should contribute as equals, not merely as research subjects (Ruijsink & Smith, 2013).

Living labs with such a network of engaged stakeholders share a common objective, leveraging diverse knowledge and expertise from the network as needed (Leminen & Westerlund, 2012).

In practice, living labs bring together a diverse array of stakeholders, including researchers, students, citizens, user communities, external individuals, non-profit organizations, small companies, universities, and policymakers, to collaboratively generate knowledge for the development of sustainable products and services in real-life settings. This inclusive and participatory approach fosters innovation that is grounded in the needs and experiences of end-users, thereby enhancing citizens' perceptions and attitudes toward living labs. In other words, the living lab should not be operated exclusively by specific stakeholders. Instead, it should function as a platform where collaborative efforts of the government, expert groups, businesses, and citizens are expressed in the problem-solving and policy-making process. This inclusive approach ensures diverse perspectives and expertise contribute to innovative solutions and effective policies. Therefore, this study hypothesized the effects of co-creation process factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H4a: Perceived co-creation process in living labs affects citizens' overall attitude.

H4b: Perceived co-creation process in living labs affects citizens' expected satisfaction.

3.1.5. Effects of Locality on Overall Attitude and Expected Satisfaction

Locality within the context of living labs is believed to exert a significant influence on citizens' overall attitudes toward these initiatives, as they address local issues and have a tangible impact on the lives of residents in the area. In light of global crises such as economic downturns and climate change, the importance of local collaboration through living labs has been underscored across various socio-economic spheres that vary from one region to another (Boersma et al., 2022). Living labs serve as catalysts for the development of innovative products and services, as well as for the diversification of the local economy, by fostering an ecosystem that enables the sustainable utilization of local resources through collaborative creation and innovative approaches involving stakeholders deeply connected to local issues (Zavratnik et al., 2019). Indeed, living labs such as the Smart Citizen Kit, CovJam, and the Seongdaegol Energy Independent Village are regarded as exemplary cases of locality-driven initiatives that have emerged from the concerns and ideas of local residents regarding seemingly mundane issues. As seen in the above cases, locality can be considered a very important factor, as it has been observed that citizens respond more actively to local urban problems and participate more in living labs. This increased engagement is likely due

to the direct impact of these issues on their daily lives, making them more invested in finding and implementing solutions. Localized issues resonate more with citizens, fostering a sense of ownership and urgency that drives their involvement in living labs. Therefore, this study hypothesized the effects of locality factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H5a: Perceived locality of living labs affects citizens' overall attitude.

H5b: Perceived locality of living labs affects citizens' expected satisfaction.

3.1.6. Effects of Openness to Public on Overall Attitude and Expected Satisfaction

Openness to the public within the context of living labs is believed to exert a significant influence on citizens' overall attitudes, as it ensures transparency throughout the entire process, from inception to outcomes, and facilitates the sharing of reliable data, contrasting with traditional closed studies. Innovation, a cornerstone of the living labs concept, underscores the importance of openness, ensuring accessibility to anyone and integrating user-centered research (Schaffers et al., 2007; Almirall & Wareham, 2011).

As evidenced in previous discussions, living labs such as CovJam in Coventry, Helsinki's Smart City Living Lab, Metaverse Seoul, and Hanam e Self serve as open data repositories that reflect citizens' opinions and inform public policy design. CovJam, for instance, as an online venture jointly launched by Coventry City and IBM, has garnered increased public participation and engagement through familiar and open platforms such as social media, underscoring the significance of openness in the operation and management of living labs (Burton, 2013). Openness can secure democratic procedures by providing an environment where anyone can participate in a living lab. This inclusivity fosters a sense of transparency and accessibility, allowing citizens to easily understand how government policies are developed and implemented. As a result, openness can also increase trust among citizens, as they can see firsthand the processes and rationale behind policy decisions. Therefore, this study hypothesized the effects of openness to public factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H6a: Perceived openness to public to living labs affects citizens' overall attitude.

H6b: Perceived openness to public to living labs affects citizens' expected satisfaction.

3.1.7. Effects of Economic Impact on Overall Attitude and Expected Satisfaction

The economic impact of living labs on the community, resulting from the innovative research process leveraging cutting-edge technologies like ICT, big data, and AI, is believed to significantly influence citizens' overall attitudes. Living labs serve as test beds for companies, allowing them to conduct innovative research with reduced trial and error, ultimately leading to economic benefits for citizens, corporations, and society as a whole. Value creation, a core principle of living labs, focuses on satisfying consumer needs rather than solely pursuing corporate profit creation through product-oriented approaches, so this emphasis on value creation is expected to generate economic benefits that resonate with citizens and contribute to the overall well-being of the community (Pino et al., 2013).

In the case of living labs such as Seongdaegol Energy Independent Village and Ma Village in Vietnam, economic issues such as power supply and farming directly impact the lives of local residents. Through studying and experimenting to find sustainable solutions, these living labs demonstrate their potential to positively influence the community's economic well-being, thereby encouraging more residents to participate in the process (Kim et al., 2017; CIAT, 2016). It is assumed that the economic impact that living labs will bring—such as job creation, maximization of corporate profits, and revitalization of the local economy—will improve citizens' awareness, attitude, and satisfaction with living labs. Therefore, this study hypothesized the effects of economic impact factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H7a: Perceived economic impact on living labs affects citizens' overall attitude.

H7b: Perceived economic impact on living labs affects citizens' expected satisfaction.

3.1.8. Effects of Social Impact on Overall Attitude and Expected Satisfaction

The social influence stemming from interactions within living labs, involving citizens, local governments, corporations, and expert groups, is believed to have a significant impact on citizens' overall attitudes toward these initiatives. In cities like Amsterdam, where the entire urban landscape serves as a canvas for living labs, citizen-centered platforms such as the Amsterdam Smart City (ASC) facilitate collaborative problem-solving for urban issues. Through this platform, citizens, research institutes, and companies can engage in ongoing dialogue, plan new projects, and provide feedback, fostering a dynamic social arena for innovation and development (Seong & Lee, 2018). Similarly, Coventry's CovJam living lab has witnessed significant social engagement, with citizens

actively participating in addressing social issues and driving meaningful change and this active involvement of citizens in living labs reflects a broader societal shift towards participatory governance and cooperative problem-solving (Burton, 2013). Ultimately, the success of living labs lies in empowering citizens to work towards a sustainable society through collaborative governance and responsive action, enabling them to adapt and respond effectively to various challenges (Jang & Kim, 2019). It is assumed that more active communication and interaction between citizens through living labs to create a better, sustainable community will act as a positive factor in enhancing citizens' awareness of living labs. Therefore, this study hypothesized the effects of social impact factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H8a: Perceived social impact on living labs affects citizens' overall attitude.

H8b: Perceived social impact on living labs affects citizens' expected satisfaction.

3.1.9. Effects of Environmental Impact on Overall Attitude and Expected Satisfaction

The environmental impact of living labs, which strive to achieve harmony between human activities and the natural environment amidst climate change, plays a significant role in shaping citizens' overall attitudes towards these initiatives. Sustainability is a pressing global concern, and living labs serve as platforms for sustainable development and innovation, making them inherently connected to environmental preservation (Leminen et al., 2016). In cities like Amsterdam, where environmental challenges like energy consumption and pollution are prominent, living labs have led to innovative solutions such as the introduction of eco-friendly vehicles like the 'Cargo Hopper' and these initiatives contribute to improving urban environments and enhancing the quality of life for citizens by reducing congestion and promoting sustainable transportation options (Seong & Lee, 2018). Similarly, the Seongdaegol Energy Independent Village Living Lab emerged from citizens' concerns about environmental issues following the Fukushima nuclear power plant accident and through this initiative, citizens aimed to create a sustainable energy village by developing mini solar panels tailored to the village's needs, highlighting the role of living labs in addressing environmental challenges and promoting sustainability (Kim et al., 2017). Preserving a sustainable environment, addressing challenges like floods, earthquakes, and extreme cold caused by climate change, has become a critical national and global policy initiative. Consequently, citizens' interest in these issues is growing. It is true that environmental concerns are occupying an increasingly larger proportion of the issues handled by living labs. Therefore, this study hypothesized the effects

of environmental impact factor on overall attitude and expected satisfaction toward living labs. Thus, the following hypotheses are proposed:

H9a: Perceived environmental impact on living labs affects citizens' overall attitude.

H9b: Perceived environmental impact on living labs affects citizens' expected satisfaction.

3.1.10. Effects of Overall Attitude on Intention to Participate in Living Labs and Expected Satisfaction

So far, this study examined how various proposed factors on living lab affect the citizens' overall attitude and expected satisfaction toward living labs. Based on this, it is ultimately necessary to analyze whether a positive attitude toward living labs affects a higher level of citizens' intention to participate in living labs and whether a positive attitude affects a higher level of citizens' expected satisfaction. Therefore, this study hypothesized the effects of positive attitude toward living labs on higher level of citizens' intention to participate in living labs and higher level of citizens' expected satisfaction. Thus, the following hypotheses are proposed:

H10a: Positive attitude toward living labs affects higher level of intention to participate for potential citizens.

H10b: Positive attitude toward living labs affects higher level of citizens' expected satisfaction.

3.2. Study 2: How Do Citizens Perceive the Growth of Living Labs in the Society?

This study is to investigate promoting factors for living lab growth, and to investigate how those factors affect citizens' attitude, expected satisfaction and intention to participate in living labs. Regarding the growth of living labs, "growth" generally refers to an increase or expansion in size, volume, or scope over time, which are measurable and often the result of strategic actions (Reserve Bank of Australia, n.d.). This encompasses a rise in the number of participants, the diversity of projects, the geographical reach, and the impact on local communities. Suggested factors are technical support, expert participation, local activist participation, and local government's policy support for living labs. Hypothesis testing examines which factors related to living labs influence citizens' attitudes, expected satisfaction and potential citizens' intention to participate in living labs.

3.2.1. Effects of Technical Support on Overall Attitude, Expected Satisfaction and Intention to Participate

In the operation and management of living labs, technical support utilizing various cutting-edge technologies such as ICT, AV, VR, Big Data, and Metaverse is considered to significantly impact citizens' attitudes toward these initiatives. Living labs have evolved as an approach to solving complex social issues by developing, testing, and refining new technologies (Leal et al., 2023). Advanced communication technologies, such as e-participation or e-government, are used to induce citizen participation in addressing urban problems and improving the quality of life in smart cities (Zheng, 2017). For instance, the Smart Citizen Kit introduced in Amsterdam is a sensor-type high-tech device that enables individuals to collect data on various environmental factors easily (Amsterdamsmartcity, 2016). Coventry's CovJam, an online venture platform integrated with IBM's IT technology, has significantly increased citizen participation in living labs (Burton, 2013). Similarly, living labs initiatives in South Korea, such as Metaverse Seoul and Hanam e-Self, leverage Metaverse and IT technology to facilitate efficient administrative services and address civil complaints online, thus promoting citizen engagement (Seoul City, 2023; Hanam City Living Lab, 2020). In summary, it assumes that technical support, which allows citizens to participate in living labs conveniently and intuitively in their daily lives, will improve citizens' awareness of living labs. Therefore, this study hypothesized the effects of technical support factor on overall attitude, expected satisfaction, and intention to participate in living labs. Thus, the following hypotheses are proposed:

H11a: Perceived technical support for living labs affects citizens' overall attitude.

H11b: Perceived technical support for living labs affects citizens' expected satisfaction.

H11c: Perceived technical support for living labs affects citizens' intention to participate in living labs.

3.2.2. Effects of Expert Participation on Overall Attitude, Expected Satisfaction and Intention to Participate

In relation to the innovative activities of living labs, the participation of expert groups from various fields, such as universities, research institutes, and companies, is considered to significantly influence citizens' overall attitudes toward living labs. Among stakeholders such as citizens, local governments, public experts, and corporations involved in the governance of living labs in cities, citizens are regarded as the most crucial participants (Oliveira, 2016). Citizens play multiple roles in revitalizing living labs to address various urban challenges, including proposers, co-creators, decision-makers, and leaders. It has been emphasized that the active involvement of citizens

includes engagement with experts in relevant fields who contribute their expertise and experiences to enhance the efficiency and innovation of living labs (Cardullo & Kitchin, 2019). Indeed, key expert groups such as university professors, research institutes, and IT companies have actively participated in various fields such as solar energy and social networks within living labs, such as Sungdaegol Energy Independent Village and CovJam. In several successful cases and existing studies, the activation of living labs and the intervention of experts providing insight and judgment on social issues have been positively evaluated and are known to have a considerable impact on citizen participation in living labs. Therefore, this study hypothesized the effects of expert participation factor on overall attitude, expected satisfaction, and intention participate in living labs. Thus, the following hypotheses are proposed:

H12a: Perceived expert participation in living labs affects citizens' overall attitude.

H12b: Perceived expert participation in living labs affects citizens' expected satisfaction.

H12c: Perceived expert participation in living labs affects citizens' intention to participate in living labs.

3.2.3. Effects of Local Activist Participation on Overall Attitude, Expected Satisfaction and Intention to Participate

It is believed that the participation of local activists, such as non-profit organizations and cooperatives, who possess in-depth knowledge and interest in local issues within living labs, significantly influences citizens' overall attitudes toward living labs. Examples from initiatives like the Seongdaegol Energy Independent Village and the Geonneoyu Project highlight the pivotal role played by local activists, including residents, university students' cooperatives, and non-profit organizations, in initiating and developing living labs by identifying and addressing social and environmental issues (Kim et al., 2017; Seong et al., 2016). For instance, the Daejeon Energy Independent Village project originated from a community-driven movement aimed at achieving energy self-sufficiency, ecological preservation, and sustainable technological transformation within the village (Hwang, 2015). The initiative established a network of power-saving stations in Daejeon and appointed a village energy manager to spearhead energy-saving campaigns and education initiatives (Bae & Shin, 2019). Moreover, the Daejeon Chungnam Green Coalition collaborated with the village community, offering support and guidance to advance the energy self-sufficiency movement (Hwang, 2015). In this way, local activists such as NGOs and cooperatives do not pursue private interests but instead seriously consider local issues such as environmental

pollution, reviving the local economy, and addressing security issues that the government or companies may hesitate to tackle. By raising these issues and making them public, they have provided more reasonable and community-centered solutions. Therefore, this study hypothesized the effects of local activist participation factor on overall attitude, expected satisfaction and intention to participate in living labs. Thus, the following hypotheses are proposed:

H13a: Perceived local activist participation in living labs affects citizens' overall attitude.

H13b: Perceived local activist participation in living labs affects citizens' expected satisfaction.

H13c: Perceived local activist participation in living labs affects citizens' intention to participate in living labs.

3.2.4. Effects of Local Government's Policy Support on Overall Attitude, Expected Satisfaction and Intention to Participate

It is considered that the policy support provided by local governments, which enables the operation and management of living labs with increased citizen participation, and ensures stable finances without excessive regulatory constraints, has a significant influence on citizens' overall attitudes toward living labs. Irrespective of a city's type or vision, it is imperative for governments and planners to address the needs and aspirations of citizens to effectively tackle urban challenges (Fung, 2015). Leveraging citizen participation to address urban issues is regarded as a hallmark of effective democratic governance, prompting local governments to explore new interaction platforms for citizen engagement (Teorell, 2006; Coleman & Blumler, 2009).

As exemplified by the policies implemented in Amsterdam City, encouraging citizen participation in living labs has been instrumental in identifying solutions to various urban problems, as citizens provide feedback on public services and developmental processes (Choo et al., 2023). In the case of living labs like the Seongdaegol Energy Independent Village, significant achievements were attained through policy support from local governments including financial assistance from the Seoul Metropolitan Government and administrative backing from the Dongjak-gu Office, showcasing the potential for sustainable living lab initiatives (Kim et al., 2017). In other words, it is assumed that the administrative and financial support of the local government, which oversees the management of the region, has contributed significantly to the revitalization of living labs. This support is believed to have a substantial influence on citizens' perception of living labs. Therefore, this study hypothesized the effects of local government's policy support factor on overall attitude, expected satisfaction, and intention to participate in living labs. Thus, the following

hypotheses are proposed:

H14a: Perceived local government's policy support for living labs affects citizens' overall attitude.

H14b: Perceived local government's policy support for living labs affects citizens' expected satisfaction.

H14c: Perceived local government's policy support for living labs affects citizens' intention to participate in living labs.

3.3. Study 3: How Do Citizens Perceive the Role of Local Government for the Sustainability of Living Labs?

3.3.1. Effects of Local Government Factors on Citizens' Intention to Participate in Living Labs

As highlighted above, the growing recognition and competitiveness of living labs have spurred cities worldwide to undertake various initiatives, including policy support, aimed at enhancing citizen participation and activating these innovative platforms. Local governments, in particular, are dedicated to improving public services by promoting, implementing, and fostering connections between living labs and citizens and stakeholders. Initiatives such as the Smart Citizen Kit, Helsinki Smart City Living Lab, and CovJam demonstrate how citizen governance can be achieved through active participation and collaboration with diverse stakeholders, supported by initiatives, publicity, administrative, and financial backing from local governments.

For instance, the Seongdaegol Energy Independent Village Living Lab, initially a grassroots initiative driven by citizens, received significant enhancements and minimized trial and error through financial support from the Seoul Metropolitan Government and administrative assistance from the Dongjak-gu Office (Kim et al., 2017). These efforts by local governments are believed to have a notable impact on citizens' intentions to participate in living labs, as they signal a commitment to fostering innovation and addressing community needs collaboratively. Regarding the more detailed roles of local governments that have supported living labs through policy, they include promoting living labs, applying social issues to living labs, involving various stakeholders in living labs, and facilitating public awareness. The support role of local governments can manifest in various ways, such as providing more practical public services implemented through social media and more actively promoting living labs. This comprehensive involvement can enhance the effectiveness and reach of living labs, fostering greater citizen engagement and support. Therefore,

this study hypothesized the effects of local government's effort factor on citizens' intention to participate in living labs. Thus, the following hypotheses are proposed:

H15: Perceived local government's effort to inform living labs affects citizens' intention to participation.

H16: Perceived local government's effort to apply living labs affects citizens' intention to participation.

H17: Perceived local government's effort to connect living labs affects citizens' intention to participation.

H18: Perceived local government's better public service for living labs affects citizens' intention to participation.

H19: Perceived local government's promotion for living labs affects citizens' intention to participation.

3.4. Study 4: How Do Citizens Perceive the Prospect of Living Labs?

When discussing the prospects for living labs, it primarily refers to potential opportunities or possibilities for future success, economic growth, and improved quality of life (Caragliu et al., 2011). While growth denotes actual increases or expansions in size or extent, prospects refer to potential opportunities or possibilities for future growth or success. Growth is measurable and often the result of strategic actions, whereas prospects represent potential paths or opportunities that may necessitate further evaluation or development.

3.4.1. Effects of Living Lab Factors on Prospects of Living Lab's Impact on City Sustainability and Expected Satisfaction

Urban sustainability has emerged as a critical priority for cities worldwide, encompassing various levels of engagement from individuals to governmental institutions. Living labs, in particular, are at the forefront of efforts to promote sustainable products and services, addressing sustainability challenges through user involvement and collaboration. As highlighted by Liu et al. (2014), living labs focus on developing sustainable solutions that cater to the needs of users while also aligning with broader sustainability goals. By engaging users in the innovation process and encouraging them to express their opinions, living labs can stimulate user involvement and facilitate the co-creation of sustainable outcomes, as argued by Buhl et al. (2017). Considering the attributes

of living labs, several factors contribute to their potential impact on city sustainability. Firstly, the growth of user-centered living labs ensures that solutions are tailored to the specific needs and preferences of users, promoting the adoption of sustainable practices and technologies. Additionally, the economic contributions of living labs can drive innovation and entrepreneurship, leading to the development of sustainable business models and economic growth within cities.

Furthermore, living labs foster social interaction and collaboration among diverse stakeholders, creating opportunities for knowledge exchange and community engagement. This social dimension is crucial for promoting sustainability, as it enables collective action and shared responsibility for addressing urban challenges.

Lastly, living labs contribute to environmental sustainability by developing and testing solutions that minimize resource consumption, reduce environmental impact, and promote ecological resilience. Through experimentation and innovation, living labs can identify and implement practices that enhance the environmental sustainability of cities, ultimately contributing to a more sustainable urban future. In other words, among the major factors mentioned above, those expected to affect the prospects of living labs include user-centered growth, economic contribution, social impact, and environmental contribution. It is assumed that these factors will positively influence the prospects of living labs, enhancing their sustainability and effectiveness. Therefore, this study hypothesized the effects of living lab factors on prospect of living lab's impact on city sustainability and expected satisfaction of citizens. Thus, the following hypotheses are proposed:

H20a: Perceived user-centered living labs' growth affects prospects of living labs.
H20b: Perceived user-centered living labs' growth affects citizens' expected satisfaction.
H21a: Perceived living labs' economic contribution affects prospects of living labs.
H21b: Perceived living labs' economic contribution affects citizens' expected satisfaction.
H22a: Perceived living labs' impact on social interactions affects prospects of living labs.
H22b: Perceived living labs' impact on social interactions affects citizens' expected satisfaction.
H23a: Perceived living labs' environmental contribution affects prospects of living labs.
H23b: Perceived living labs' environmental contribution affects citizens' expected satisfaction.

IV. Methodology

4.1. Data Collection

The study aims to assess the impact of various factors on citizens' expected satisfaction and intention to participate in living labs. Data was collected through an online survey administered by a professional online panel company. The survey targeted adult men and women residing in South Korea, with quotas set for gender, age, region, and other relevant demographics.

The questionnaire provided participants with an introduction to living labs, including definitions and examples familiar to citizens in their everyday lives. Examples such as Daejeon City's Geonneoyu project, which utilizes smartphones to monitor river flooding, and the "Shining Workwear" project aimed at enhancing the safety of street cleaners working at night, were included to illustrate the potential benefits of living labs in improving quality of life. The questionnaire consists of warm-up questions, main questions, and demographic questions. Further, the main question parts were composed of four parts: i) How citizen perceive the impact of living labs in the society? for study 1; ii) How citizen perceive the growth of living labs in the society for study 2; iii) How citizen perceive the role of local government for the sustainability of living labs? for study 3; and iv) How citizen perceive the prospect of living labs for study 4. For study 1, this study developed questionnaire items for major factors such as citizen participation, real-life condition, multi-method, co-creation process, locality, openness to public, impact on economy, impact on society and impact on environment. For study 2, this study developed questionnaire items for technical support, expert participation, local activist participation, and local government's policy support for living labs. For study 3, this study developed questionnaire items for local government's effort how to inform the meaning of living labs to citizens, how to put an effort to apply living labs in our society, how to play a key role to make citizens to participate living labs, how to provides better public services by applying living labs, and how to actively promote the role of living labs to citizens. For study 4, this study developed questionnaire items related to prospect of living labs including user-centered consistent growth, living labs' economic contribution, living labs' impact on social interactions, and living labs' environmental contribution.

This study applied a 5-point Likert scale of 1 – strongly disagree and 5 – strongly agree for major variables. Finally, the total of 300 respondents completed the survey, consisting of 28 living lab participants and 272 potential living lab participants. The survey invitation was sent to 3,123 people, and 358 adult men and women participated in the survey, therefore, the response rate was

11.5%. 58 respondents were eliminated through dropout and screening. In order to check reliability of factors developed with various questionnaire items, this study conducted Cronbach's alpha tests. The results of Cronbach alpha include the following: 0.872 for citizen participation, 0.824 for real-life condition, 0.818 for multi-method, 0.875 for co-creation process, 0.875 for locality, 0.837 for openness to public, 0.834 for impact on economy, 0.847 for impact on society and 0.864 for impact on environment in the case of study 1, while 0.811 for technical support, 0.881 for expert participation, 0.892 for local activist participation, and 0.863 for local government policy support in the case of study 2. The results are summarized in Table 4 and 5.

Table 4. Cronbach's Alpha for the Test of Reliability (Study 1)

Factors	Statements	Cronbach's Alpha
Citizen participation	1. Living labs are operated by reflecting citizens' opinions. 2. Living labs are usually operated by citizen participation. 3. Citizens often hesitate to participate in living labs if it is not operated by citizens. 4. Citizens might prefer living labs in which citizens actively participate. 5. Citizens will participate more in living labs if there have an opportunity of autonomy using platforms. 6. Since living labs are part of social issues, citizens might be willing to participate actively in living labs.	0.872
Real-life condition	5. Living labs are operated in real life condition. 6. Living labs usually focus on citizens' quality of lives. 7. Citizens often hesitate to participate in living labs if these are not operated to improve quality of life through technological innovation. 8. Citizens might prefer living labs, if these focus on the real-life problems of citizens. 9. Citizens will participate more in living labs that deal with real-life issues of citizens.	0.824
Multi-method	5. Living Labs are operated in diverse ways. 6. Living labs are usually operated in more innovative ways. 7. Citizens often hesitate to participate in living labs if these are not operated in diverse ways to solve the problem. 8. Citizens might prefer living labs that are operated in a free and comfortable way. 9. Citizens will participate more in living labs with diverse solution processes.	0.818
Co-creation process	5. Living labs work with cooperation of stakeholders such as corporations, governments, experts, and citizens. 6. Outcomes of living labs are usually developed in collaboration with multi-stakeholders. 7. Citizens will participate in living labs if these are operated with participants with proper contribution. 8. Citizens might prefer living labs with participants who strive for creative solutions through innovative ideas. 9. Citizens will participate more in living labs with the co-creation process.	0.875
Locality	5. Living labs are usually operated on a local basis. 6. Living labs are usually operated by local citizen participation.	0.875

	7. Citizens will participate in living labs if these are operated by local citizens. 8. Citizens might prefer living labs that deal with local issues. 9. Citizens will participate more in living labs dealing with local issues.	
Openness to public	5. Any citizen can participate in living labs. 6. The innovation process of living labs is open to public. 7. Citizens might prefer living labs with openness 8. Citizens will participate in living labs if these are operated with openness.	0.837
Impact on economy	5. I think that participation in living labs contributes to the local economy. 6. Living labs have a positive impact on revitalizing the local economy through innovation. 7. Citizens often hesitate to participate in living labs if these don't have any economic impact. 8. Citizens might prefer living lab policies that are beneficial to the economy. 9. Citizens will participate more in living labs with economic impacts.	0.834
Impact on society	5. I think that participation in living labs contributes to a sustainable community such as urban regenerations. 6. Living lab participation has a positive impact on citizens' social interactions. 7. Citizens often hesitate to participate in living labs if these are not operated for the society. 8. Citizens might prefer living lab policies that create social values. 9. Citizens will participate more in living labs pursuing social value.	0.847
Impact on environment	5. I think that participation in living labs contributes to the creation of a sustainable environment. 6. Living lab participation has a positive impact on innovative environmental preservation. 7. Citizens might prefer to participate in living labs related to eco-friendly policies. 8. Citizens will participate more in living labs dealing with environmental issues due to climate change.	0.864

Table 5. Cronbach's Alpha for the Test of Reliability (Study 2)

Factors	Statements	Cronbach's Alpha
Technical support	5. Technical support will be helpful in the policy-making process of living labs. 6. Online living labs should be more facilitated to increase participation. 7. Advanced technology such as AI, Metaverse will be helpful to attract citizen participation in living labs. 8. If living labs consider more user-centered technology based on ICT, citizens will participate more in living labs.	0.811

Expert participation	5. Experts' advices in diverse fields will be helpful in the policy-making process of living labs. 6. The policy decision in living labs should be made with the help of experts' opinion. 7. Expert participation in living labs will further revitalize citizen-centered living labs. 8. If living labs consider more on social issues based on experts' opinions, citizens will participate more in living labs.	0.881
Local activist participation	5. Local activists' advices in diverse fields will be helpful in the policy-making process of living labs. 6. The policy decision in living labs should be made with the help of local activists' opinion. 7. Local activists' participation in living labs will further revitalize citizen-centered living labs 8. If living labs consider more on social issues based on local activists' opinions, citizens will participate more in living labs.	0.892
Local government policy support	5. Local government's policy support will be helpful in the policy-making process of living labs. 6. The policy decision in living labs should be made with the help of local government support. 7. Local government's policy support in living labs will further revitalize citizen-centered living labs 8. If living labs consider more on social issues based on local government's policy support, citizens will participate more in living labs.	0.863

Among respondents, 50.0% were female and 50.0% were male. Among respondents, 7.3% were working at educational institution, 2.3% were working at government sector, 5.0% were working at public corporate sector, 45.7% were working at private sector, 10.0% were self-employed, 13.7% were housewives, 8.3% were students, and 5.0% were others. Regarding age groups, 6.0% were 21-24 years old, 21.3% were 25-29 years old, 17.3% were 30-34 years old, 10.7% were 35-39 years old, 17.0% were 40-44 years old, 11.0% were 45-49 years old, 12.0% were 50-54 years old, and 4.7% were over 50-59 years old. In terms of education level, 17.0% had high school graduate, 14.0% had 2-year associate degree, 62.3% had bachelor's degree, 6.3% had master's degree, and 0.3% had Ph.D. degree. For marital status, 46.3% were married and 53.7% were unmarried. Regarding average annual salary, 12.7% earned below 10,000,000 KRW, 7.7% earned more or equal to 10,000,000 ~ below 20,000,000 KRW, 16.3% earned more or equal to 20,000,000 ~ below 30,000,000 KRW, 23.0% earned more or equal to 30,000,000 ~ below 40,000,000 KRW, 13.7% earned more or equal to 40,000,000 ~ below 50,000,000 KRW, 7.0% earned more or equal to 50,000,000 ~ below 60,000,000 KRW, 8.3% earned more or equal to 60,000,000 ~ below 70,000,000 KRW, and 11.3% earned more or equal to 70,000,000 KRW. Table 6 summarized demographic characteristic of respondents.

Among respondents, 33.0% answered that they aware living labs, while 67.0% do not aware

living labs. Among respondents, 9.3% answered that they had participated living labs' project, while 90.7% don't have experience with living labs' project.

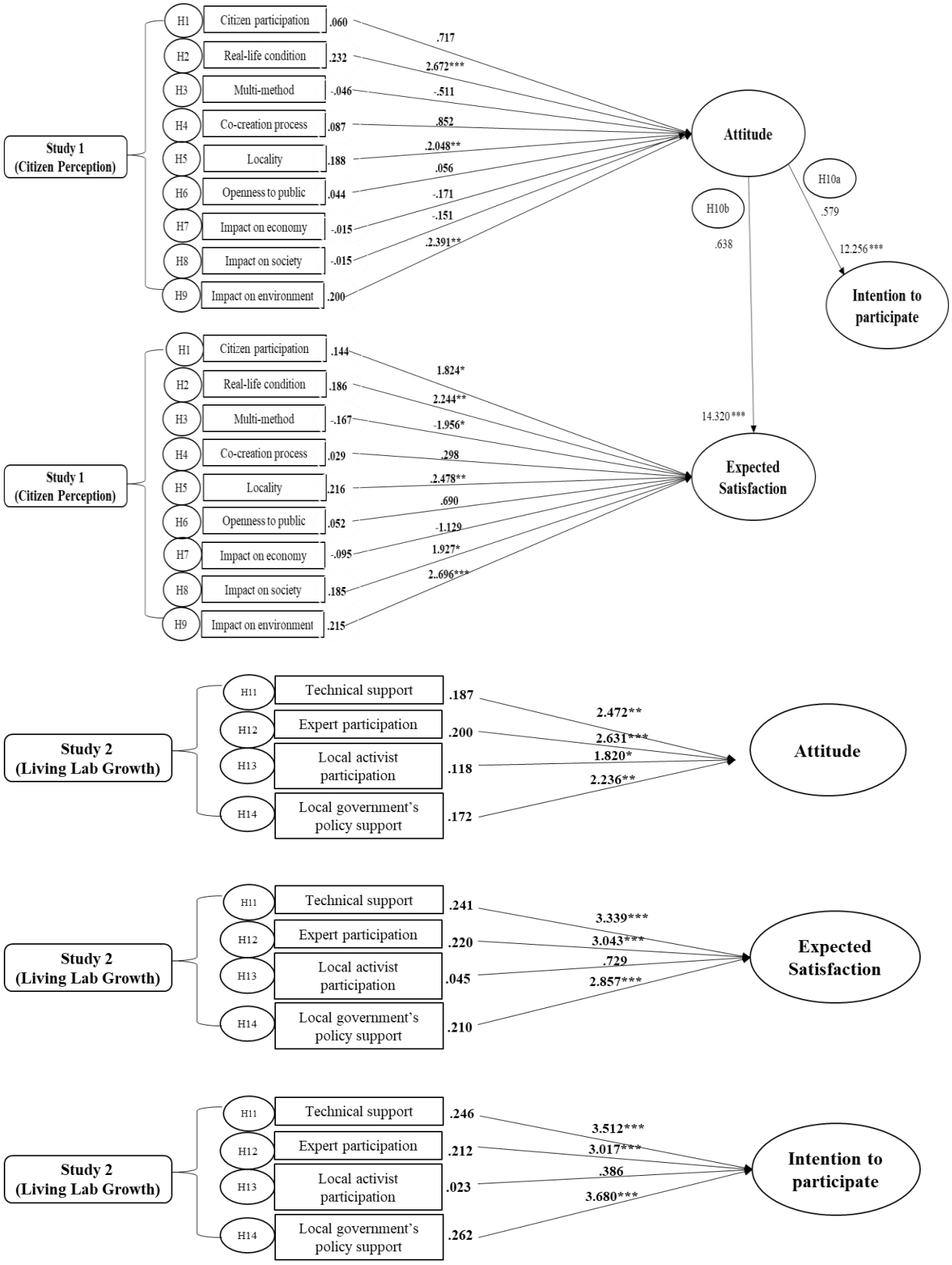
Table 6. Summary of Demographics

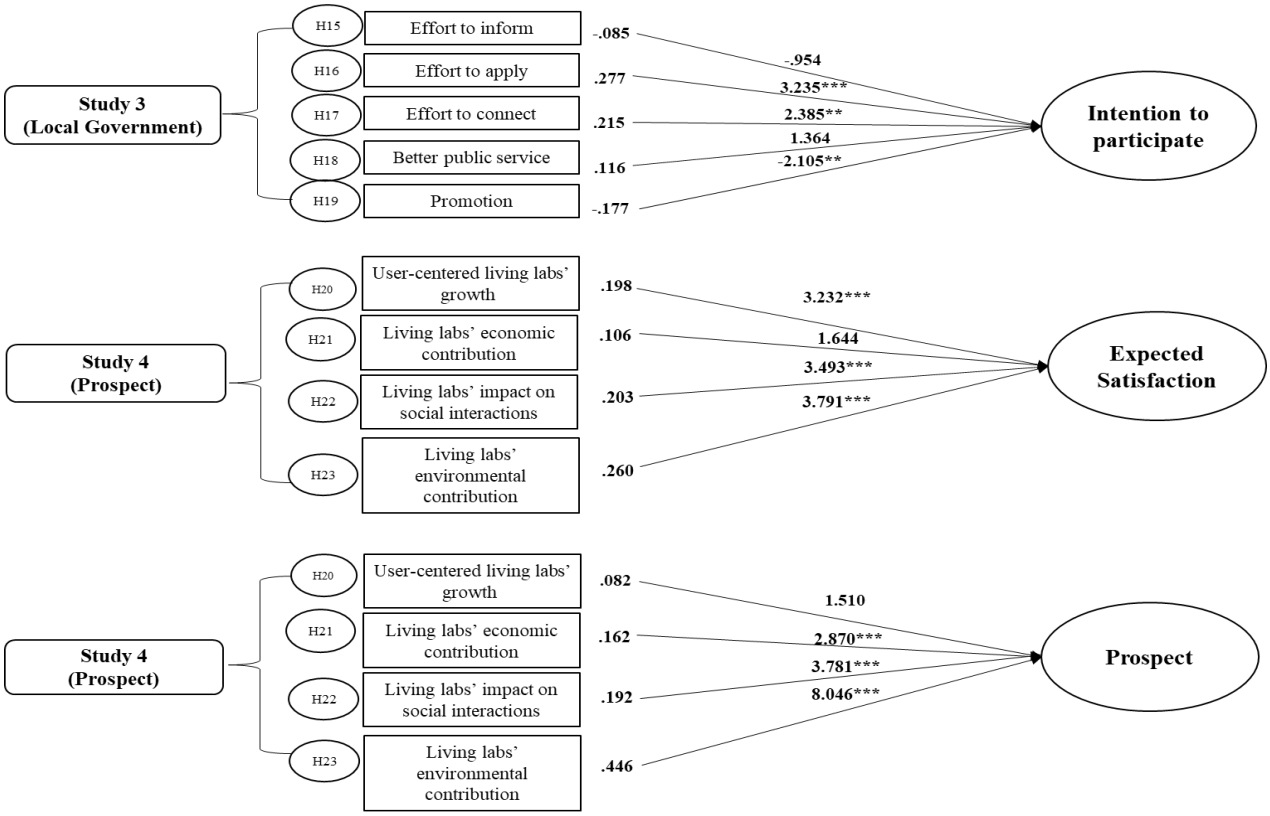
Category	Citizens (300)	
	%	*N*
Gender		
Male	50.0%	(150)
Female	50.0%	(150)
Occupation		
Educational institution	7.3%	(22)
Government sector	2.3%	(7)
Public corporate sector	5.0%	(15)
Private sector	45.7%	(137)
Self-employed	10.0%	(30)
Research institution	2.7%	(8)
Housewife	13.7%	(41)
Student	8.3%	(25)
Others	5.0%	(15)
Age		
21-24 years old	6.0%	(18)
25-29 years old	21.3%	(64)
30-34 years old	17.3%	(52)
35-39 years old	10.7%	(32)
40-44 years old	17.0%	(51)
45-49 years old	11.0%	(33)
50-54 years old	12.0%	(36)
55-59 years old	4.7%	(14)
Education		
High school graduate	17%	(51)
2-year associated degree	14%	(42)
Bachelor degree	62.3%	(187)
Master degree	6.3%	(19)
Ph.D. degree	0.3%	(1)
Marriage		
Married	46.3%	(139)
Unmarried	53.7%	(161)
Average Annual Salary		
Below KRW 10,000,000	12.7%	(38)
More or equal to KRW 10,000,000 ~ below KRW 20,000,000	7.7%	(23)
More or equal to KRW 20,000,000 ~ below KRW 30,000,000	16.3%	(49)
More or equal to KRW 30,000,000 ~ below KRW 40,000,000	23.0%	(69)
More or equal to KRW 40,000,000 ~ below KRW 50,000,000	13.7%	(41)
More or equal to KRW 50,000,000 ~ below KRW 60,000,000	7.0%	(21)
More or equal to KRW 60,000,000 ~ below KRW 70,000,000	8.3%	(25)
More or equal to KRW 70,000,000	11.3%	(34)

4.2. Data Analysis

The multiple regression analysis for studies 1, 2, 3 and 4 is shown in figure 2 below.

Figure 2. The Logic Model of Multiple Regression Analysis in Study 1, 2, 3 & 4





Note: This figure is an integration of the multiple regressions that are modeled and analyzed in this study.

4.2.1. Study 1: How Citizen Perceive the Impact of Living Labs in the Society?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including citizen participation, real-life condition, multi-method, co-creation process, locality, openness to public, impact on economy, impact on society, impact on environment. Table 7 summarized the results of factor analysis for each factor of living labs.

Table 7. Component Matrix: Factors of Living Labs

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9
Citizen Participation 5	Citizens will participate more in living labs if there have an opportunity of autonomy using platforms.	.836								
Citizen Participation 4	Citizens might prefer living labs in which citizens actively participate.	.815								
Citizen Participation 6	Since living labs are part of social issues, citizens might be willing to participate actively in living labs.	.807								

Citizen Participation 1	Living labs are operated by reflecting citizens' opinions.	.778								
Citizen Participation 3	Citizens often hesitate to participate in living labs if it is not operated by citizens.	.734								
Citizen Participation 2	Living labs are usually operated by citizen participation.	.721								
Real-life Condition 4	Citizens might prefer living labs, if these focus on the real-life problems of citizens.		.837							
Real-life Condition 5	Citizens will participate more in living labs that deal with real-life issues of citizens.		.800							
Real-life Condition 2	Living labs usually focus on citizens' quality of lives.		.765							
Real-life Condition 1	Living labs are operated in real life condition.		.742							
Real-life Condition 3	Citizens often hesitate to participate in living labs if these are not operated to improve quality of life through technological innovation.		.686							
Multi-Method 4	Citizens might prefer living labs that are operated in a free and comfortable way.			.807						
Multi-Method 2	Living labs are usually operated in more innovative ways.			.796						
Multi-Method 5	Citizens will participate more in living labs with diverse solution processes.			.792						
Multi-Method 3	Citizens often hesitate to participate in living labs if these are not operated in diverse ways to solve the problem.			.750						
Multi-Method 1	Living Labs are operated in diverse ways.			.655						
Co-Creation 3	Citizens will participate in living labs if these are operated with participants with proper contribution.				.858					
Co-Creation 4	Citizens might prefer living labs with participants who strive for creative solutions through innovative ideas.				.822					
Co-Creation 5	Citizens will participate more in living labs with the co-creation process.				.807					
Co-Creation 1	Living labs work with cooperation of stakeholders such as corporations, governments, experts, and citizens.				.799					
Co-Creation 2	Outcomes of living labs are usually developed in collaboration with multi-stakeholders.				.796					
Locality 3	Citizens will participate in living labs if these are operated by local citizens.					.857				

Locality 2	Living labs are usually operated by local citizen participation.					.825				
Locality 4	Citizens might prefer living labs that deal with local issues.					.824				
Locality 5	Citizens will participate more in living labs dealing with local issues.					.811				
Locality 1	Living labs are usually operated on a local basis.					.765				
Openness to Public 3	Citizens might prefer living labs with openness.						.867			
Openness to Public 4	Citizens will participate in living labs if these are operated with openness.						.829			
Openness to Public 1	Any citizen can participate in living labs.						.807			
Openness to Public 2	The innovation process of living labs is open to public.						.779			
Impact on Economy 4	Citizens might prefer living lab policies that are beneficial to the economy.							.843		
Impact on Economy 5	Citizens will participate more in living labs with economic impacts.							.833		
Impact on Economy 1	I think that participation in living labs contributes to the local economy.							.799		
Impact on Economy 2	Living labs have a positive impact on revitalizing the local economy through innovation.							.796		
Impact on Economy 3	Citizens often hesitate to participate in living labs if these don't have any economic impact.							.602		
Social Impact 4	Citizens might prefer living lab policies that create social values.								.862	
Impact on Society 5	Citizens will participate more in living labs pursuing social value.								.853	
Impact on Society 1	I think that participation in living labs contributes to sustainable community such as urban regenerations.								.835	
Impact on Society 2	Living lab participation has a positive impact on citizens' social interactions.								.806	
Impact on Society 3	Citizens often hesitate to participate in living labs if these are not operated for the society.								.576	
Impact on Environment 1	I think that participation in living labs contributes to the creation of a sustainable environment.									.857
Impact on Environment 4	Citizens will participate more in living labs dealing with environmental issues due to climate change.									.848
Impact on Environment 3	Citizens might prefer to participate in living labs related to eco-friendly policies.									.842

Impact on Environment 2	Living lab participation has a positive impact on innovative environmental preservation.									.827

This study applied factor scores for multiple regression analysis to find out the significance of each factor on overall attitude toward living labs. ANOVA results showed that *R-square* = .429 and overall, the regression model was significant with F = 24.173 (at alpha of 0.01 level). As summarized in Table 8, the results showed that effects of real-life condition, locality, and impact on environment on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level H2a, 5a, and 9a were significantly accepted. Among significant factors, effect size for real-life condition showed greater than other factors, followed by impact on environment and locality. Therefore, the results found that how citizens prefer living labs with focus on the real-life problems of citizens, how citizens expect to participate more in living labs that deal with real-life issues of citizens, how citizens perceive living labs with operation in real life condition particularly through technological innovation affect overall attitude toward the living labs with greater effect size. The results also found that how citizens consider participation in living labs that contributes to the creation of a sustainable environment, consider more in living labs dealing with environmental issues due to climate change, and prefer to participate in living labs related to eco-friendly policies affect overall attitude toward the living labs. The results also found that how citizens consider to participate in living labs that deal with local issues affect overall attitude toward the living labs.

Table 8. Effects of Factors on Citizens' Attitudes toward Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Citizen participation → Attitude (H1a)	.060 (.717)
Real-life condition → Attitude (H2a)	.232 (2.672***)
Multi-method → Attitude (H3a)	-.046 (-.511)
Co-creation process → Attitude (H4a)	.087 (.852)
Locality → Attitude (H5a)	.188 (2.048**)
Openness to public → Attitude (H6a)	.044 (.560)
Impact on economy → Attitude (H7a)	-.015 (-.171)
Impact on society → Attitude (H8a)	-.015 (-.151)
Impact on environment → Attitude (H9a)	.200 (2.391**)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

This study applied factor scores for multiple regression analysis to find out the significance of each factor on expected satisfaction toward living labs. ANOVA results showed that *R-square*

= .483 and overall, the regression model was significant with F = 30.044 (at alpha of 0.01 level). As summarized in Table 9, the results showed that effects of real-life condition and locality on expected satisfaction were significant at alpha 0.05 level and impact on environment on expected satisfaction were significant at alpha 0.01 level. The results also showed that effects of citizen participation and multi-method on expected satisfaction were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H2b, 5b, and 9b were accepted. Among significant factors, effect size for locality showed greater than other factors, followed by impact on environment and real-life condition. Therefore, the results found that how citizens perceive living labs based on locality affect expected satisfaction toward the living labs with greater effect size. The results also found that how citizens consider to participate in living labs if these are operated based on real-life condition with impact on environment. The results implies that how citizens consider participation in living labs that contributes to the creation of a sustainable environment, consider more in living labs dealing with environmental issues due to climate change, and prefer to participate in living labs related to eco-friendly projects in real life.

Table 9. Effects of Factors on Citizens' Expected Satisfaction

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Citizen participation → Expected Satisfaction (H1b)	.144 (1.824*)
Real-life condition → Expected Satisfaction (H2b)	.186 (2.244**)
Multi-method → Expected Satisfaction (H3b)	-.167 (-1.956*)
Co-creation process → Expected Satisfaction (H4b)	.029 (.298)
Locality → Expected Satisfaction (H5b)	.216 (2.478**)
Openness to public → Expected Satisfaction (H6b)	.052 (.690)
Impact on economy → Expected Satisfaction (H7b)	-.095 (-1.129)
Impact on society → Expected Satisfaction (H8b)	.185 (1.927*)
Impact on environment → Expected Satisfaction (H9b)	.215 (2.696***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

Table 10 is provided to compare multiple regression analyses in the cases of dependent variables including overall attitude and expected satisfaction toward living labs (Table 8 and 9). As summarized in Table 10, by applying alpha 0.01 level and 0.05 level, the results showed that effects of real-life condition, locality and impact on environment on attitude and expected satisfaction toward the living labs in common were significant. Therefore, H2, 5 and 9 were significantly accepted in the cases of dependent variables including overall attitude and expected satisfaction toward the living labs. The effect size of locality on expected satisfaction toward living labs showed

greater than other factors, while the effect size of real-life condition on overall attitude showed greater than other factors. Therefore, the results found that how citizens expect to participate more in living labs that deal with local issues in society. The results also found that how citizens consider to participate more in living labs with real-life condition particularly through technologies affect attitude and expected satisfaction toward the living labs. The results also found that how citizens consider to participate more in living labs with impact on environment affect attitude and expected satisfaction toward the living labs. The results also found that effects of citizen participation, multi-method, and impact on society on expected satisfaction showed significance at alpha of 0.1 level, while effects of citizen participation, multi-method, and impact on society on attitude does not show significance. The results provide implications that citizens' perception on real-life condition, locality and impact on environment has a significance on the attitude and expected satisfaction toward the living labs, which is connected to the intention of participation. The results also found that effects of co-creation process, openness to public and impact on economy on both attitude and expected satisfaction toward the living labs do not show significance. The results provide implications that citizens may lack experience in factors such as co-creation process, openness to public and impact on economy, or may not perceive how to make co-creation process, open to public and impact on economy in living labs.

Table 10. Comparison of Regression Analysis by Dependent Variable

Variable (Independent)	**Standardized Coefficient (*t*-value-Sig)**	
	Variable (dependent)	
	Attitude (a)	**Expected Satisfaction (b)**
Citizen participation (H1)	.060 (.717)	.144 (1.824*)
Real-life condition (H2)	.232 (2.672***)	.186 (2.244**)
Multi-method (H3)	-.046 (-.511)	-.167 (-1.956*)
Co-creation process (H4)	.087 (.852)	.029 (.298)
Locality (H5)	.188 (2.048**)	.216 (2.478**)
Openness to public (H6)	.044 (.560)	.052 (.690)
Impact on economy (H7)	-.015 (-.171)	-.095 (-1.129)
Impact on society (H8)	-.015 (-.151)	.185 (1.927*)
Impact on environment (H9)	.200 (2.391**)	.215 (2.696***)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ denotes statistical significance

This study applied factor scores for regression analysis to find out the significance of overall attitude on intention to participate in living labs and expected satisfaction toward living labs. As

summarized in Table 11, for the effects of overall attitude on intention to participate in living labs, ANOVA results showed that *R-square* = .335 and overall, the regression model was significant with *F* = 150.212 (at alpha 0.01 level). For the effects of overall attitude on expected satisfaction, the ANOVA results showed *R-square* = .408 and overall, the regression model was significant with *F* = 205.050 (at alpha 0.01 level). The results showed that effects of overall attitude on intention to participate and expected satisfaction were significant. Therefore, H10a, 10b were significantly accepted. Therefore, the results found that how citizens perceive living labs with a positive overall attitude affect intention to participate in living labs and expected satisfaction toward living labs.

Table 11. Effects of Factors on Intention and Expected Satisfaction of Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Overall Attitude → Intention to Participate (H10a)	.579 (12.256***)
Overall Attitude → Expected Satisfaction (H10b)	.638 (14.320***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

4.2.2. Study 2: How Citizen Perceive the Growth of Living Labs in the Society?

This study checked the validity by using factor analysis. This study applied extraction method with Principal Component Analysis. This study selected factors that Eigen values are greater than 1.00 for major variables including technical support, expert participation, activist participation, local government's policy support. Table 12 summarized the results of factor analysis for each factor of living labs.

Table 12. Component Matrix: Factors of Living Labs

Factors	Scale Items	Components (Citizen)								
		1	2	3	4	5	6	7	8	9
Technical Support 4	If living labs consider more user-centered technology based on ICT (e.g., Hanam e Itself, Metaverse Seoul), citizens will participate more in living labs.	.832								
Technical Support 3	Advanced technology such as AI, Metaverse (e.g., Metaverse Seoul) will be helpful to attract citizen participation in living labs.	.804								
Technical Support 2	Online living labs should be more facilitated to increase participation.	.782								
Technical Support 1	Technical support will be helpful in the policy-making process of living labs.	.776								
Expert Participation 4	If living labs consider more on social issues based on experts'		.875							

	opinions, citizens will participate more in living labs.									
Expert Participation 3	Expert participation in living labs will further revitalize citizen-centered living labs.		.867							
Expert Participation 1	Experts' advices in diverse fields will be helpful in the policy-making process of living labs.		.856							
Expert Participation 2	The policy decision in living labs should be made with the help of experts' opinion.		.838							
Local Activist Participation 4	If living labs consider more on social issues based on local activists' opinions, citizens will participate more in living labs.			.882						
Local Activist Participation 3	Local activists' participation in living labs will further revitalize citizen-centered living labs			.881						
Local Activist Participation 2	The policy decision in living labs should be made with the help of local activists' opinion.			.877						
Local Activist Participation 1	Local activists' advices in diverse fields will be helpful in the policy-making process of living labs.			.837						
Local Government's Policy Support 3	Local government's policy support in living labs will further revitalize citizen-centered living labs				.864					
Local Government's Policy Support 1	Local government's policy support will be helpful in the policy-making process of living labs.				.846					
Local Government's Policy Support 4	If living labs consider more on social issues based on local government's policy support, citizens will participate more in living labs.				.834					
Local Government's Policy Support 2	The policy decision in living labs should be made with the help of local government support.				.824					

This study applied factor scores for multiple regression analysis to find out the significance of each factor on attitude toward living labs. ANOVA results showed that *R-square* = .349 and overall, the regression model was significant with F = 39.492 (at alpha of 0.01 level). As summarized in Table 13, by applying alpha 0.01 level and 0.05 level, the results showed that effects of technical support, expert participation and local government's policy support on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level, H11a, 12a and 14a were significantly accepted. Among significant factors, effect size for expert participation showed greater

than other factors, followed by technical support and local government's policy. Therefore, the results found that how citizens perceive living labs with expert participation affect attitude toward living labs with greater effect size. The results also found that how citizens consider to participate more in living labs with technical support and local government's policy support affect attitude toward the living labs.

Table 13. Effects of Factors on Citizens' Attitudes toward the Growth of Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Technical support → Attitude (H11a)	.187 (2.472**)
Expert participation → Attitude (H12a)	.200 (2.631***)
Local activist participation → Attitude (H13a)	.118 (1.820*)
Local government's policy support → Attitude (H14a)	.172 (2.236**)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

This study applied factor scores for multiple regression analysis to find out the significance of each factor on expected satisfaction toward living labs. ANOVA results showed that *R-square* = .406 and overall, the regression model was significant with $F = 50.401$ (at alpha of 0.01 level). As summarized in Table 14, the results showed that effects of technical support, expert participation and local government's policy support on expected satisfaction were significant. Therefore, H11b, 12b and 14b were significantly accepted. Among significant factors, effect size for technical support showed greater than other factors, followed by expert participation and local government's policy support. Therefore, the results found that how citizens prefer living labs with technical support, how citizens expect to participate more in living labs that are supported by advanced technologies such as ICT, IOT, Metaverse, AR and Big Data, how citizens perceive living labs with advanced technologies affect expected satisfaction toward the living labs with greater effect size. The results also found that how citizens consider to participate more in living labs with expert participation and local government's policy support affect expected satisfaction toward the living labs.

Table 14. Effects of Factors on Citizens' Expected Satisfaction toward the Growth of Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Technical support → Expected Satisfaction (H11b)	.241 (3.339***)
Expert participation → Expected Satisfaction (H12b)	.220 (3.043***)
Local activist participation → Expected Satisfaction (H13b)	.045 (.729)
Local government's policy support → Expected Satisfaction (H14b)	.210 (2.857***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

This study applied factor scores for multiple regression analysis to find out the significance of each factor on intention to participate in living labs. ANOVA results showed that *R-square* = .443 and overall, the regression model was significant with F = 58.537 (at alpha of 0.01 level). As summarized in Table 15, the results showed that effects of technical support, expert participation and local government's policy support on intention to participate in living labs were significant. Therefore, H11c, 12c and 14c were significantly accepted. Among significant factors, effect size for local government's policy support showed greater than other factors, followed by technical support and expert participation. Therefore, the results found that how citizens perceive living labs with local government's policy support affect intention to participate in living labs with greater effect size. The results also found that how citizens consider to participate more in living labs with technical support and expert participation affect intention to participate in living labs.

Table 15. Effects of Factors on Citizens' Intention to Participate in Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Technical support → Intention (H11c)	.246 (3.512***)
Expert participation → Intention (H12c)	.212 (3.017***)
Local activist participation → Intention (H13c)	.023 (.386)
Local government's policy support → Intention (H14c)	.262 (3.680***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

Table 16 is provided to compare multiple regression analyses in the cases of dependent variables including overall attitude, expected satisfaction and intention to participate in living labs (Table 13, 14 and 15). As summarized in Table 16, the results showed that effects of technical support, expert participation and local government's policy support on attitude, expected satisfaction and intention to participate in living labs in common were significant. Therefore, H11, 12 and 14 were significantly accepted in the cases of dependent variables including overall attitude, expected satisfaction and intention to participate in living labs. The results found that how citizens perceive living labs with advanced technologies affect attitude, expected satisfaction and intention to participate in living labs. The results found that how citizens perceive living labs participated by experts affect attitude, expected satisfaction and intention to participate in living labs. The results also found that how citizens perceive living labs supported by local government's policy affect attitude, expected satisfaction and intention to participate in living labs. The results also found that effects of local activist participation on attitude showed significance at alpha of 0.1 level, while

effects of local activist participation on expected satisfaction and intention to participate in living labs does not show significance.

Table 16. Comparison of Regression Analysis by Dependent Variable

Variable (Independent)	Standardized Coefficient (*t*-value-Sig)		
	Variable (dependent)		
	Attitude (a)	Expected Satisfaction (b)	Intention (c)
Technical support (H11)	.187 (2.472**)	.241 (3.339***)	.246 (3.512***)
Expert participation (H12)	.200 (2.631***)	.220 (3.043***)	.212 (3.017***)
Local activist participation (H13)	.118 (1.820*)	.045 (.729)	.023 (.386)
Local government's policy support (H14)	.172 (2.236**)	.210 (2.857***)	.262 (3.680***)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

4.2.3. Study 3: How Citizen Perceive the Role of Local Government for the Sustainability of Living Labs?

This study applied factor scores for multiple regression analysis to find out the significance of each factor. ANOVA results showed that *R-square* = .145 and overall, the regression model was significant with $F = 9.982$ (at alpha of 0.01 level). As summarized in Table 17, the results showed that effects of local government's effort to apply, local government's effort to connect and local government's promotion on intention to participate in living labs were significant. Therefore, H16, 17 and 19 were significantly accepted. Among significant factors, effect size for local government's effort to apply showed greater than other factors, followed by local government's effort to connect and local government's promotion. Therefore, the results found that how citizens perceive living labs with local government's effort to apply affect intention to participate in living labs with greater effect size. The results also found that effects of local government's effort to connect and local government's promotion on intention to participate in living labs showed significance.

Table 17. Effects of Local Government Factors on Citizens' Intention to Participate in Living Labs

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Local government's effort to inform → Intention (H15)	-.085 (-.954)
Local government's effort to apply → Intention (H16)	.277 (3.235***)
Local government's effort to connect → Intention (H17)	.215 (2.385**)
Local government's better public service → Intention (H18)	.116 (1.364)
Local government's promotion→ Intention (H19)	-.177 (-2.105**)

*** p < 0.01, ** p < 0.05, * p < 0.1 denotes statistical significance

4.2.4. Study 4: How Citizen Perceive the Prospect of Living Labs?

This study applied factor scores for multiple regression analysis to find out the significance of each factor including user-centered living labs' growth, living labs' economic contribution, impact on social interactions, and environmental contribution on prospect of living labs. Overall, ANOVA results showed that *R-square* = .605 and overall, the regression model was significant with $F = 90.243$ (at alpha of 0.01 level). As summarized in Table 18, the results showed that effects of living labs' economic contribution, living labs' impact on social interactions and living labs' environmental contribution on the prospect of sustainable living labs were significant at alpha 0.01 level. Therefore, H21a, 22a and 23a were accepted. Among significant factors, effect size for living labs' environmental contribution showed greater than other factors, followed by living labs' impact on social interaction and economic contribution.

Further, this study applied factor scores for multiple regression analysis to find to find out proposed factors including user-centered living labs' growth, living labs' economic contribution, impact on social interactions, and environmental contribution on expected satisfaction. Overall, ANOVA results showed that *R-square* = .506 overall, the regression model were significant with and $F = 49.964$ (at alpha of 0.01 level). As shown in Table 18, the results showed that effects of user-centered living labs' growth, living labs' impact on social interactions and living labs' environmental contribution on expected satisfaction were significant. Therefore, H20b, 22b and 23b were significantly accepted. Among significant factors, effect size for living labs' environmental contribution showed greater than other factors, followed by living labs' impact on social interactions and user-centered living labs' growth. Therefore, the results found that how citizens perceive living labs with environmental contribution affect expected satisfaction with greater effect size. The results implies that how citizens perceive living labs' economic contribution, living labs' impact on social interaction and living labs' environmental contribution affect prospect of living labs. The results also implies that how citizens consider participation in user-centered living labs that contribute to the creation of a sustainable environment with impact on social interaction and prefer to participate in user-centered living labs with impact on social interaction and environmental contribution.

Table 18. Effects of Living Lab Factors on Prospect and Citizens' Expected Satisfaction

Variable (Independent)	Standardized Coefficient (t-value-Sig)
	Variable (dependent)

	Prospect (a)	Expected Satisfaction (b)
User-centered living labs' growth (H20)	.082 (1.510)	.198 (3.232***)
Living labs' economic contribution (H21)	.162 (2.870***)	.106 (1.644)
Living labs' impact on social interactions (H22)	.192 (3.781***)	.203 (3.493***)
Living labs' environmental contribution (H23)	.446 (8.046***)	.260 (3.791***)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ denotes statistical significance

V. Conclusion

5.1. The Summary of Findings

The aim of this study is to investigate the factors influencing citizens' overall attitude, expected satisfaction, and intention to participate in living labs. Specifically, it examines how various aspects such as the impact of living labs, their growth, the role of local governments in fostering sustainable living labs, and the future prospects of living labs affect citizens' perceptions and willingness to engage with such initiatives.

Firstly, regarding how citizens perceive the impact of living labs in study 1, the results of this study showed that effects of real-life condition, locality, and impact on environment on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level H2a, 5a, and 9a were significantly accepted. Among significant factors, effect size for real-life condition on overall attitude showed greater than other factors, followed by impact on environment and locality. The results of this study also showed that effects of real-life condition and locality on expected satisfaction were significant at alpha 0.05 level and impact on environment on expected satisfaction were significant at alpha 0.01 level. The results also showed that effects of citizen participation and multi-method on expected satisfaction were significant at alpha 0.1 level. Therefore, by applying alpha 0.01 level and 0.05 level, H2b, 5b, and 9b were significantly accepted. Among significant factors, effect size for locality on expected satisfaction showed greater than other factors, followed by impact on environment and real-life condition. Therefore, the results of this study found that real-life condition, locality and impact on environment showed significance on both overall attitude and expected satisfaction toward the living labs, which expect to be connected to the intention of participation on living labs. The results also found that effects of co-creation process, openness to public and impact on economy on both attitude and expected satisfaction toward the living labs do not show significance. Therefore, H2, 5 and 9 were accepted.

The results also showed that effects of overall attitude on intention to participate and expected

satisfaction were significant. Therefore, H10a, 10b were significantly accepted. The results implies that citizens perceive on real-life condition, locality and impact on environment as more significant factors in determining their attitude and expected satisfaction toward living labs. The results also implies that citizens who perceive living labs with a positive overall attitude prefer to participate in living labs and perceive expected satisfaction toward living labs more positively. Regarding the factors of co-creation process, openness to public and impact on economy, the results showed no significance on both attitude and expected satisfaction toward the living labs. It implies that citizens may consider effects of co-creation process, openness to public and impact on economy as less important than effects of real-life condition, locality, and impact on environment on citizens' attitudes and expected satisfaction toward the living labs. Or, it implies that citizens may not be aware of their meaning since such factors as co-creation process, openness to public and impact on economy are more tangible things that citizens can understand when they directly participate in living labs.

Secondly, regarding how citizens perceive the growth of living labs in the society in study 2, by applying alpha 0.01 level and 0.05 level, the results of this study showed that effects of technical support, expert participation and local government's policy support on overall attitude were significant. Therefore, by applying alpha 0.01 level and 0.05 level, H11a, 12a and 14a were significantly accepted. Among significant factors, effect size for expert participation on overall attitude showed greater than other factors, followed by technical support and local government's policy. The result of this study also showed that effects of technical support, expert participation and local government's policy support on expected satisfaction were significant. Therefore, H11b, 12b and 14b were significantly accepted. Among significant factors, effect size for technical support on expected satisfaction showed greater than other factors, followed by expert participation and local government's policy support. The result of this study also showed that effects of technical support, expert participation and local government's policy support on intention to participate in living labs were significant. Therefore, H11c, 12c and 14c were significantly accepted. Among significant factors, effect size for local government's policy support on intention to participate in living labs showed greater than other factors, followed by technical support and expert participation. The results of this study found that effects of technical support, expert participation and local government's policy support on attitude, expected satisfaction and intention to participate in living labs in common were significant. The results also found that effects of local activist participation on attitude showed significance at alpha of 0.1 level, while effects of local activist participation on

expected satisfaction and intention to participate in living labs does not show significance. Therefore, H11, 12 and 14 were accepted. The results implies that citizens perceive technical support, expert participation and local government's policy support as more significant factors in determining their attitude, expected satisfaction and intention to participate in living labs.

Thirdly, regarding how citizens perceive the role of local government for sustainable living labs in study 3, the results of this study showed that effects of local government's effort to apply, local government's effort to connect and local government's promotion on intention to participate in living labs were significant. Among significant factors, effect size for local government's effort to apply on intention to participate living labs showed greater than other factors, followed by local government's effort to connect and local government's promotion. Therefore, H16, 17 and 19 were significantly accepted. The results implies that citizens perceive local government's effort to apply, local government's effort to connect and local government's promotion as more significant factors in determining their intention to participate in living labs.

Lastly, regarding how citizens perceive the prospect of living labs in study 4, the results of this study showed that effects of living labs' economic contribution, living labs' impact on social interactions and living labs' environmental contribution on prospect of living labs were significant at alpha 0.01 level. Therefore, H21a, 22a and 23a were accepted. Among significant factors, effect size for living labs' environmental contribution on prospect of living labs showed greater than other factors, followed by living labs' impact on social interaction and economic contribution. The results of this study also showed that effects of user-centered living labs' growth, living labs' impact on social interactions and living labs' environmental contribution on expected satisfaction were significant. Therefore, H20b, 22b and 23b were significantly accepted. Among significant factors, effect size for living labs' environmental contribution on expected satisfaction showed greater than other factors, followed by living labs' impact on social interactions and user-centered living labs' growth. The results implies that citizens perceive user-centered living labs' growth, living labs' impact on social interactions and living labs' environmental contribution as more significant factors related to the prospects of living labs. It also implies that citizens perceive user-centered living labs' growth, living labs' impact on social interactions and living labs' environmental contribution as more significant factors in determining their expected satisfaction toward living labs.

5.2. Policy and Managerial Implications

The findings of this study offer valuable insights for both managerial and policy domains. By

gaining a deeper understanding of the meanings and scopes of living labs from the perspective of citizens, efforts can be directed towards developing and establishing these initiatives more effectively within society. Policymakers should focus on crafting and promoting policies that enhance public awareness, thereby fostering the sustainable growth of living labs. Moreover, it's essential to ensure that promotional efforts and policy preparations are inclusive across various social classes to maximize the benefits and participation in living labs initiatives.

Looking more specifically, based on Study 1, citizens consider real-life conditions and locality to be major factors influencing the impact and expected satisfaction of living labs. Therefore, concerning living labs policy, the government should promote policies that focus on creating more practical living labs that can address and resolve various issues directly experienced by citizens in the region. According to Study 2, concerning the growth of living labs, citizens favored the involvement of experts, technical support, and policy backing from local governments. Therefore, the government should ensure the free participation of experts in living lab policies to enhance the reliability of the problem-solving process. Additionally, efforts should be made to expedite the development of technology that enables broader and safer citizen participation. Furthermore, given the regional focus of living labs, there is an urgent need to establish policies facilitating the practical and effective operation of living labs under the authority and management of local governments. Based on Study 3, in relation to the specific role of local government in the establishment and growth of sustainable living labs, policies should be promoted to create an environment wherein any local challenge can be addressed within living labs, and where citizens and relevant stakeholders can participate freely and express their opinions in the problem-solving process beyond the current formal gathering. Based on Study 4, concerning the prospects of living labs, citizens prioritize the environmental contribution of living labs having the greatest impact. Therefore, local governments should align living lab initiatives with the international agenda of fostering a sustainable environment in collaboration with the central government. Furthermore, there is a need to intensify efforts in promoting policies aimed at establishing living labs capable of practically addressing environmental issues alongside citizens.

5.2.1. Discussion from Study 1

From Study 1, this study found that factors including real-life condition, locality, and impact on environment on attitude and expected satisfaction toward the living labs showed significance. Therefore, the results meet the meanings of living labs that considered enhanced local inclusion by

applying real-life condition and environmental issues such as climate change and energy consumption in sustainable societies. Among significant factors, the effect size of real-life condition on attitudes showed greater than other factors. This implies how citizens perceive living labs that focus on improving quality of life, particularly dealing with real-life condition affect attitude toward living labs. Among significant factors, the effect size of locality on expected satisfaction showed greater than other factors. This implies how citizens perceive living labs that operate based on local society and deal with local problems affect expected satisfaction.

However, this study found that factors including co-creation process, openness to public and impact on economy on attitude and expected satisfaction toward the living labs did not show significance. Indeed, living labs play a role in supporting various stakeholders by integrating issues of policing and business development for the public good in the perspective of social integration. Beaudoin et al. (2022) highlighted that the magnitude of environmental challenges we are facing today requires the involvement of a diversity of stakeholders and collaborators to develop socially, culturally, and economically robust sustainability practices. The fact that the co-creation process did not show significance in this study is a significant gap from previous studies that have emphasized the collaboration of various stakeholders in living labs. Further, effects of citizen participation, multi-method, impact on economy and society on attitude toward living labs did not show significance due to many reasons such as lack of awareness of meaning of living labs.

According to Table 19, 90.7% of citizens have not participated in living labs, and 87.7% of citizens are not aware of living labs. This implies that citizens have heard of living labs, but still are properly not aware of the meaning and the process of living labs. Given the low awareness among citizens in South Korea, it is essential to enhance their understanding and participation in living labs to foster a more favorable attitude, satisfaction, and prospect toward these initiatives. Study 1 underscores the need for improved promotional policies aimed at conveying the significance of living labs to enhance citizen awareness and participation. Currently, although citizen-centered living labs policies are promoted by the central government, actual implementation and application of living labs are primarily the responsibility of local governments. However, the overall lack of awareness among citizens regarding living labs does not align with the expectations set by government policies. Moreover, the lower level of awareness and participation among citizens hampers the potential success of living lab initiatives in contributing to sustainable societies. Therefore, concerted efforts are needed to bridge this gap and ensure that citizens are adequately informed and engaged in living lab projects.

5.2.2. Discussion from Study 2

From Study 2, this study found that factors including technical support, expert participation and local government's policy support in common on overall attitude, expected satisfaction and intention to participate in living labs showed significance. Therefore, this implies that citizens prefer living labs that are more technologically advanced and can be verified by experts, and that are more stable and sustainable through local government policy support. Living labs offer an opportunity for all stakeholders including expert participation to develop the city together in a real-life setting and mutual understanding among stakeholders is developed through the innovative processes of living labs, which is very useful in solving local problems. This implies that citizens perceive living labs with the participation of experts including related companies in the entire process from discovery to resolution of urban problems, and that citizens prefer to participate in such living labs. Juujärvi and Pesso (2013) also emphasized that collaboration between stakeholders is crucial for the creation of innovative services, and in particular, creating networks and engaging citizens are keys for successful living labs.

The results of Study 2 also implies that the important factors in vitalizing living labs are the voluntary participation of citizens and local governments' policy support and efforts that can make it possible. Hence, it is imperative for local governments to proactively facilitate the involvement of expert groups and provide technical support to address any challenges citizens may face in participating in living labs. Additionally, local governments should enact policies aimed at establishing comprehensive procedures and standardized management practices for living labs. Moreover, in identifying real-life issues, efforts should focus on measuring and promoting commercialization to seek practical solutions at the local government level, rather than solely highlighting problems within the local community.

5.2.3. Discussion from Study 3

From Study 3, this study found that factors including local government's effort to apply living labs, local government's effort to connect living labs, and local government's promotion on intention to participate in living labs showed significance, while factors including local government's effort to inform living labs to citizens and local government' better public service on intention to participate in living labs did not show significance. The results implies that the role of local governments is crucial in promoting and encouraging citizens to participate more actively in

living labs by applying living labs to various problems and connecting them with citizens. According to Table 19, 59% of citizens think that the application of living labs is important in our community, and 72.6% of citizens feel that more information is needed to be aware of the meaning of living labs. In addition, 76.7% citizens recognized that there should be more frequent promotion related to living labs to increase awareness and 51.3% of citizens thought that living labs were part of local government policies. The higher mean values of the results suggest that citizens perceive living labs operated and managed by local governments with policy support more favorably, indicating a preference for participation in such initiatives. This underscores the belief among citizens that local governments should actively apply living labs to address local issues as a policy measure. Furthermore, citizens expect local governments to provide more information to raise awareness about living labs and to promote these initiatives more frequently to enhance citizen engagement and participation.

5.2.4. Discussion from Study 4

From Study 4, this study found that factors including living labs' economic contribution, living labs' impact on social interactions, and living labs' environmental contribution on prospect of living labs showed significance. This study also found that factors including user-centered living labs' growth, living labs' impact on social interactions and living labs' environmental contribution on expected satisfaction showed significance. Regarding the prospect of living labs and expected satisfaction, as citizens perceive in common factors such as environmental contribution and social interactions have a more significant impact, the implication is that policies should be developed that can implement a living lab platform that can serve as a venue for social interaction among citizens while addressing environmental issues resulting from climate change or energy consumption issues. By considering the effect size among significant factors, the results implies that both citizens perceive that living labs' environmental contributions have a more significant impact on the prospect of living labs and expected satisfaction toward living labs. As showed in Table 19, 39% of citizens thought that the purpose of living labs was to achieve sustainable environment for the future. This suggests that the policy direction of local governments for living labs should prioritize environmental achievements aimed at fostering a sustainable society. Additionally, the results regarding the lack of significance in the effects of economic contribution on expected satisfaction align with the findings of Study 1.

The implications of this study offer insights for both managerial and policy initiatives aimed

at enhancing citizens' awareness of living labs, improving citizen participation, and promoting the societal benefits of implementing living labs. Finally, considering that living labs and urban regeneration share common goals in addressing local community living environment issues, integrating living labs with urban regeneration projects could lead to greater synergy and contribute to the development of sustainable living labs centered on citizen participation.

5.3. Limitation and Future Study

The study acknowledges several limitations that can guide future research in this area. Firstly, the data collection was limited to ordinary citizens in South Korea, which may have restricted the generalizability of the findings. Future studies could benefit from larger and more diverse samples, including individuals with direct experience with living labs. Furthermore, the study focused on citizen-centered living labs, neglecting other types of living labs led by different actors. Future research could explore a broader range of living lab models and analyze how different factors influence citizen awareness and participation across these various models. Additionally, this study does not contain analysis results by incorporating demographic data as control variables including age, gender and region. The reasons are as follows. The same independent variables and citizens' attitudes toward living labs and expected satisfaction were set as dependent variables, with demographic data including age, gender, and region set as control variables and the same analysis was applied. However, from ANOVA and regression analysis results, it is found that there was no significant difference in the results with or without the control variables. Future research could consider diverse analysis including demographic factors including age, gender, region, occupation, education level and income level as control variables to provide a more comprehensive understanding of how these variables influence citizens' perceptions of living labs based on a larger sample size.

Moreover, the study's findings may be limited to the context of South Korea. Future research could explore cross-national comparisons to examine how cultural and contextual differences impact citizens' perceptions of living labs in different countries. Lastly, the study focused on general satisfaction and intention to participate in living labs, without considering regional characteristics or funding sources. Future research could delve deeper into these factors to provide a more nuanced understanding of citizen satisfaction and participation in living labs across diverse contexts.

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Internet Resources

https://amsterdamsmartcity.com

https://fiksukalasatama.fi/

https://hri.fi/en

https://livinglab.hanam.go.kr/

https://openlivinglabs.eu/aboutus

https://www.seoul.go.kr/

Appendix A

Questionnaire

Citizen awareness and satisfaction survey related to living labs

Thank you for answering this survey. This survey is proposed to investigate your opinions about living labs (laboratory). Your responses will be treated strictly confidential. This survey is anonymous and intended for research purpose only. Also, this survey will be conducted with your voluntary participation.

If you have experienced living labs, please respond the questions based on your experience. If you have not experienced living labs, please respond the questions based on what you think of living labs.

The European Network of Living Labs (ENoLL) defines living labs as "user-centered, open innovation ecosystem based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings." (U4IOT, 2018). Living labs in Korea serve as a window to create its own smart city that solves various problems while encouraging citizens to participate in a smart city. There are living lab examples such as "Geonneoyu" project in Daejeon, where citizens developed a service to check river flooding with a smartphone during heavy rain and "Shiny work clothes" that keep the safety of sanitation workers working at night.

(Source: http://eoun.net/news/aricleView.html?idxno=3591 http://eoun.net/news/aricleView.html?idxno=20219)

1. Have you ever heard of living labs?
   (1) Yes, I have heard. (2) No, I have not heard.

2. Have you ever participated in living labs?

(1) Yes, I have participated. (2) No, I have not participated.

3. How much do you aware living labs?

←Strongly Negative			Neutral		Strongly Positive→
1	2		3	4	5

4. (If yes on the question 2, answer this question. If no on the question 2, then go to the question 5)

If you have participated in living labs, how much are you satisfied with living labs in general? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

5. If you have an opportunity to participate in living labs, how much you expect to be satisfied with living labs in general? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

6. These following questions are asked about the definition of living labs. Please answer each question below.

		Strongly disagreed----neutral-----strongly agreed				
		1	2	3	4	5
1	Living labs are real or virtual environments, or interaction spaces for sustainable society.					
2	Living labs are networks that integrate both user-centered research and open innovation.					
3	Living labs are a methodology for user engagement.					
4	Living labs are online platforms in which city, citizens and companies participate in the entire process from discovery to resolution of urban problems such as environment, energy, and welfare (e.g., “Geonneoyu”, “Shiny work clothes”).					
5	Living labs are “user-centered, open innovation ecosystem based on systematic user co-creation approach, integrating research and innovation processes in real life communities and settings.”					

7. What is the best described purpose of a living lab? Please select only one.

(1) To create economic profit for all stakeholders

(2) To achieve sustainable environment for the future

(3) To view users as active, competent partners and domain experts

(4) To carry out innovation activities in a realistic, natural, real-life setting

(5) To open up the innovation process with a flow of knowledge

8. I think that I aware the meaning of living labs.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

9. I think that application of the living labs is important in our community.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

10. I would like to have more information about living labs to aware the meaning of it.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

11. There should be more frequent promotion related to living labs to increase awareness.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

12. I think that living labs are part of local government policy.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

Part 1: Impact of Application of Living Labs on Citizen and Society

1. Citizen participation (active & multi-stakeholder participation)

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Living labs are operated by reflecting citizens' opinions.					
2	Living labs are usually operated by citizen participation.					
3	Citizens often hesitate to participate in living labs if it is not operated by citizens.					
4	Citizens might prefer living labs in which citizens actively participate.					
5	Citizens will participate more in living labs if there have an opportunity of autonomy using platforms (e.g., "Hanam e Itself" in which Hanam city, citizens, and companies actively participate online in the entire					

	process from discovering to solving urban problems such as environment, energy, and welfare.).					
6	Since living labs are part of social issues, citizens might be willing to participate actively in living labs.					

2. Real-life condition

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Living labs are operated in real life condition.					
2	Living labs usually focus on citizens' quality of lives.					
3	Citizens often hesitate to participate in living labs if these are not operated to improve quality of life through technological innovation.					
4	Citizens might prefer living labs, if these focus on the real-life problems of citizens.					
5	Citizens will participate more in living labs that deal with real-life issues of citizens.					

3. Multi-method

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Living Labs are operated in diverse ways.					
2	Living labs are usually operated in more innovative ways. (e.g., "Metaverse Seoul" is a public service that provides career counseling and necessary information by using an avatar that looks like oneself and interacting in the virtual world on the web like in the real world.).					
3	Citizens often hesitate to participate in living labs if these are not operated in diverse ways to solve the problem.					
4	Citizens might prefer living labs that are operated in a free and comfortable way.					
5	Citizens will participate more in living labs with diverse solution processes.					

4. Co-creation process

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Living labs work with cooperation of stakeholders such as corporations, governments, experts, and citizens.					
2	Outcomes of living labs are usually developed in collaboration with multi-stakeholders.					

3	Citizens will participate in living labs if these are operated with participants with proper contribution.					
4	Citizens might prefer living labs with participants who strive for creative solutions through innovative ideas.					
5	Citizens will participate more in living labs with the co-creation process.					

5. Locality

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Living labs are usually operated on a local basis.					
2	Living labs are usually operated by local citizen participation.					
3	Citizens will participate in living labs if these are operated by local citizens.					
4	Citizens might prefer living labs that deal with local issues.					
5	Citizens will participate more in living labs dealing with local issues.					

6. Openness to public

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Any citizen can participate in living labs.					
2	The innovation process of living labs is open to public. (e.g., social issues, problem solving methods)					
3	Citizens might prefer living labs with openness.					
4	Citizens will participate in living labs if these are operated with openness.					

7. Impact on economy

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	I think that participation in living labs contributes to the local economy.					
2	Living labs have a positive impact on revitalizing the local economy through innovation.					
3	Citizens often hesitate to participate in living labs if these don’t have any economic impact.					
4	Citizens might prefer living lab policies that are beneficial to the economy.					
5	Citizens will participate more in living labs with economic impacts.					

8. Impact on society

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	I think that participation in living labs contributes to a sustainable community such as urban regenerations.					
2	Living lab participation has a positive impact on citizens' social interactions.					
3	Citizens often hesitate to participate in living labs if these are not operated for the society.					
4	Citizens might prefer living lab policies that create social values.					
5	Citizens will participate more in living labs pursuing social value.					

9. Impact on environment

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	I think that participation in living labs contributes to the creation of a sustainable environment.					
2	Living lab participation has a positive impact on innovative environmental preservation.					
3	Citizens might prefer to participate in living labs related to eco-friendly policies.					
4	Citizens will participate more in living labs dealing with environmental issues due to climate change.					

Part 2: Role of local government for Sustainable Growth of the Society by Applying Living Labs

1. I think that local government tries to inform the meaning of living labs to citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

2. I think that local government tries to apply living labs in our society.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

3. I think that local government plays a role to connect citizens to participate in living labs.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

4. I think that local government plays a role to provide better public service by applying living labs.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

5. I think that local government actively promotes the role of living labs to citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

Part 3: How to foster living labs in a society

1. Technical support for living labs

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Technical support will be helpful in the policy-making process of living labs.					
2	Online living labs should be more facilitated to increase participation.					
3	Advanced technology such as AI, Metaverse (e.g., Metaverse Seoul) will be helpful to attract citizen participation in living labs.					
4	If living labs consider more user-centered technology based on ICT (e.g., Hanam e Itself, Metaverse Seoul), citizens will participate more in living labs.					

2. Expert participation in living labs

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Experts' advices in diverse fields will be helpful in the policy-making process of living labs.					
2	The policy decision in living labs should be made with the help of experts' opinion.					
3	Expert participation in living labs will further revitalize citizen-centered living labs.					
4	If living labs consider more on social issues based on experts' opinions, citizens will participate more in living labs.					

3. Local activist participation in living labs

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5

1	Local activists' advices in diverse fields will be helpful in the policy-making process of living labs.					
2	The policy decision in living labs should be made with the help of local activists' opinion.					
3	Local activists' participation in living labs will further revitalize citizen-centered living labs					
4	If living labs consider more on social issues based on local activists' opinions, citizens will participate more in living labs.					

4. Local government's policy support for living labs

		Strongly disagreed--- neutral ----strongly agreed				
		1	2	3	4	5
1	Local government's policy support will be helpful in the policy-making process of living labs.					
2	The policy decision in living labs should be made with the help of local government support.					
3	Local government's policy support in living labs will further revitalize citizen-centered living labs					
4	If living labs consider more on social issues based on local government's policy support, citizens will participate more in living labs.					

13. Please choose a main reason that citizens might not actively participate in living labs. Select one that applies the most.
    (1) Lack of relevant information
    (2) Don't know how to get involved
    (3) Lack of technical support
    (4) The issues handled by living labs are far from real life.
    (5) Not sure if my opinion is reflected or not
    (6) Lack of expert involvement
    (7) Lack of local activist involvement
    (8) Lack of support from local government

14. Do you feel like participating in living labs if more opportunities were given based on sufficient information? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

15. Do you feel like participating living labs if given the opportunity to participate in an easier way? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

16. What is your overall attitude toward living labs? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

17. Please answer your overall satisfaction based on your experience of living labs. Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

18. Please answer how much do you expect to be satisfied with living labs in general? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

19. What do you think if your neighbors participate in policy discussions related to living labs? Please answer by perspectives of citizens.

←Strongly Negative		Neutral		Strongly Positive→
1	2	3	4	5

20. These following questions are asked about the prospects of living labs in Korea. Please answer each question below.

		Strongly disagreed---- neutral-----strongly agreed				
		1	2	3	4	5
1	User-centered living labs will grow constantly in Korea.					
2	It is expected that living labs contributes to overall economic development in Korea.					
3	It is expected that living labs contributes to overall social development in Korea.					
4	Living labs will have a positive impact on social interactions among citizens.					
5	Living labs will have a positive impact on the sustainability of the city.					
6	Living labs will have a positive impact on the sustainability of environment.					

21. Please select your gender.
    (1) Male
    (2) Female

22. Please select your occupation.
    (1) Employee in the educational institution
    (2) Public officer
    (3) Employee in the public sector
    (4) Employee in the profit sector
    (5) Self-employed
    (6) Employee in the research institution
    (7) Housewife
    (8) Student
    (9) Others ( )

23. Please select your age group.
    (1) 20 years old ~ 24 years old
    (2) 25 years old ~ 29 years old
    (3) 30 years old ~ 34 years old
    (4) 35 years old ~ 39 years old
    (5) 40 years old ~ 44 years old
    (6) 45 years old ~ 49 years old
    (7) 50 years old ~ 54 years old
    (8) 55 years old ~ 59 years old
    (9) 60 years old ~ 63 years old
    (10) more than 65 years old

24. Please select your final education.
    (1) Middle school graduate
    (2) High school graduate
    (3) 2-year associated degree
    (4) Bachelor’s degree
    (5) Master’s degree
    (6) Ph.D.

25. Please select your marital status.
    (1) Married
    (2) Unmarried

26. Please select the range of your annual salary.
    (1) Below KRW 10,000,000
    (2) More or equal to KRW 10,000,000 ~ below KRW 20,000,000
    (3) More or equal to KRW 20,000,000 ~ below KRW 30,000,000
    (4) More or equal to KRW 30,000,000 ~ below KRW 40,000,000
    (5) More or equal to KRW 40,000,000 ~ below KRW 50,000,000
    (6) More or equal to KRW 50,000,000 ~ below KRW 60,000,000
    (7) More or equal to KRW 60,000,000 ~ below KRW 70,000,000
    (8) More or equal to KRW 70,000,000

Thank you for participating this survey.