Project Report of Master of Engineering

Governance, Policy, and Services (GPS) Smart City Framework: Learning from Korean Smart City Programs

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Notice

This project report cites or includes the contents of papers that we published while researching at the Graduate School of Engineering Practice, Seoul National University.

1. Lee, J., Lee, U., Yoon, E., and Park, C. (2021). Segway Model for the Assessment of Megaproject Excellence: Project Excellence Baseline Approach to the Korea's Pilot Smart City Projects (Sejong 5-1 Life Zone and Busan Eco Delta Smart City). In Research on Project, Programme and Portfolio Management (pp. 191-202). Springer, Cham.

2. Kwak, Y. H. and Lee, J. (2020). Evolution of Korean Smart City Programs: Challenges and Opportunities. Paper presented at the 2020 IEEE Technology & Engineering Management Conference (TEMSCON).

3. Kwak, Y. H. and Lee, J. (2020). Towards Sustainable Smart City: Lessons from 20 years of Korean Programs. Paper submitted to IEEE Transactions on Engineering Management (submitted 02-Nov-2020).

Abstract

South Korea has a long history of the planning, development, and management of smart cities to integrate emerging technological advances into complex physical infrastructure. However, a long-term successful smart city model has yet to be introduced. This study explores lessons learned from smart city programs in South Korea to better understand the challenges and opportunities of future sustainable smart city innovation and development.

This research was guided by a research question: What are the essential characteristics of a successful sustainable smart city beyond technology adaptation and implementation? To define this research question, this research conducted a comprehensive review and qualitative analysis of South Korea's smart city programs and conceptualized a sustainable smart city framework that will assist policymakers, planners, citizens, and other key stakeholders. To do so, firstly, this research interweaves megaproject and smart city literature reviews. One of author's previous research discussed smart cities have similar characteristics to megaprojects [1]. Secondly, media articles collected to identify key factors during the execution of smart city programs. The key factors validated with multi-source evidence. Lastly, framework was developed by mean of comprehensive case analysis on Korea smart city programs and literature reviews.

The findings of this research answer our research question. First, the Smart City Master Planner and Project Governance Board are key to the success of smart cities. Second, regulatory innovation can revolutionize smart

city services. Third, it is critical to provide services that reflect the ideas and demands of citizens rather than to provide a service in a packaged form that often fails in action. This research proposed Governance, Policy, and Services (GPS) as the three pillars of a successful smart city framework, in addition to integrating physical and cyber infrastructures. The study argues that a smart city should function as a service platform that incubates and delivers long-term services to citizens and society. This study also emphasizes that a strong groundwork of the GPS framework will lead to the successful adaptation of innovative technologies and ideas for future smart city programs.

Keywords : Smart City, Case study, Framework, Governance, Policy, Services, South Korea

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Contents

List of Figures

List of Tables

Chapter 1

Introduction

1.1 Background

Advances in technology have greatly expanded the boundaries of cities. More people currently choose to live in cities for expanded economic opportunities and advantages. In 2018, 55% of the world's population lived in urban areas and this number is estimated to increase to nearly 68% by 2050 (see Figure 1). In the case of Asia, urbanization increased from 27% to 59% between 1950 and 2018 and in Korea the urbanization is at 82% [2]. Urbanization is characterized by a number of challenges such as a lack of basic infrastructure such as roads, water, energy, land supply, and healthcare, which can also be exacerbated by man-made problems [6].

To solve urban problems and improve the quality of life, the smart city has emerged as a social aspiration wherein various services are provided by converging information and communication technologies (ICT) with the physical infrastructure. Table 1 shows the detailed description of smart city components, dominant spaces, and contents. Building a smart city is an undertaking akin to a complex infrastructure development megaproject in which a number of diverse stakeholders, such as contractors, urban planners, policymakers, provide services that are integrated with advanced technologies such as artificial intelligence, big data, autonomous vehicles, etc.

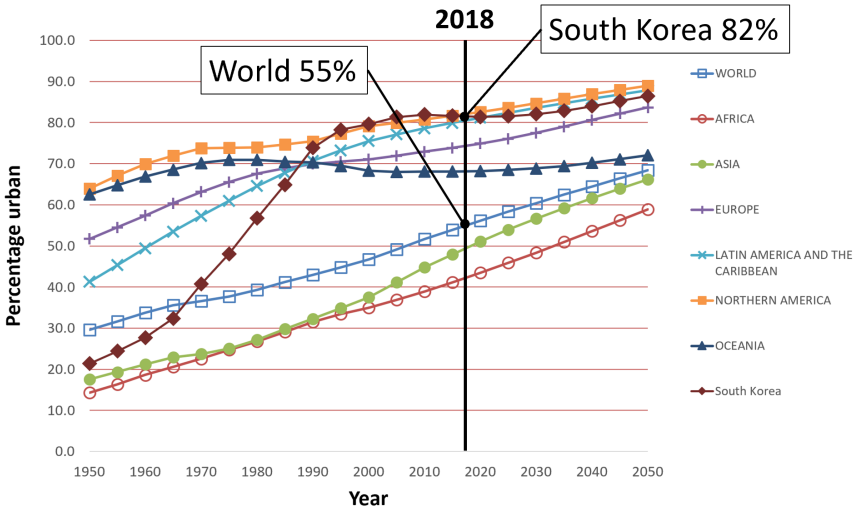

Figure 1: World Urbanization (Data source: [2])

As a result, smart city projects often face various challenges and obstacles that make them difficult to plan, implement, and operate. Understanding these challenges in integrating technical fields into comprehensive planning and management is essential [7]. In addition, the governance structure and policies that foster various specialties in a smart city play a crucial role in carrying out complex smart city projects.

Previous research on smart cities have proposed socio-technical changes and have discussed how new technologies and systems can be applied in smart cities and change the lives of their citizens. Albert Meijer and Manuel Pedro Rodríguez Bolívar [8] analyzed technology, governance, and citizen issues, but did not examine the intricacy of smart city initiatives [9]. To provide synergistic effects, an innovative smart city framework is required to plan and manage smart city development and operations. South Korea has

Table 1: Three components of Smart cites [4]

Smart city Components	**Dominant Spaces**	**Contents**
Construction Infrastructure	Physical space	Buildings, residences, roads, public transportation, electrical grid, etc.
ICT Infrastructure	Media interconnecting Physical space and Digital space	Internet service, Wi-fi networks, CCTV, fiber optic networks, multipurpose sensor networks, service-oriented information system, integrated control center, communication network, etc.
Services	Digital space	Traffic control, water treatment, garbage disposal, energy solution, security, healthcare, car sharing, etc.

built smart cities since the early 2000s. The number of local governments in South Korea planning smart city initiatives has continually expanded, increasing from 10 in 2014, to 34 in 2018, to 78 in 2019 [10].

This study examines holistic approaches to smart city development, planning, implementation, and operation by critically reviewing completed smart city projects in South Korea.

1.2 Purpose of Research

This study differs from other previous studies on smart city by asking the following research question. “What are the essential characteristics of a successful sustainable smart city beyond technology adaptation and implementation?”. To answer this question, this study examines the history and evolution of 20 years of South Korea’s smart city initiatives and challenges to explore the key factors for the long-term sustainability of smart city. First, past studies and news articles as well as publicly available government reports were reviewed to identify the unique characteristics of smart city development during the planning, implementation, and management phases. Second, since smart city development has many characteristics similar to megaprojects [1], this study investigated the managerial and practical implications from megaproject literature to match commonly occurred issues in smart cities and megaprojects. Based on the lessons learned from the past South Korean smart city programs, this study proposes a smart city framework that consists of Governance, Policy, and Services (GPS) as the three pillars of a sustainable smart city program. Among the three pillars, this study argues that smart city services are the critical component for the long-term sustainability of smart city programs that contribute to the citizens. This study concludes that without early planning and the establishment of a steady revenue stream designated to fund services, the success to build and promote a sustainable smart city program is limited.

1.3 Research Structure

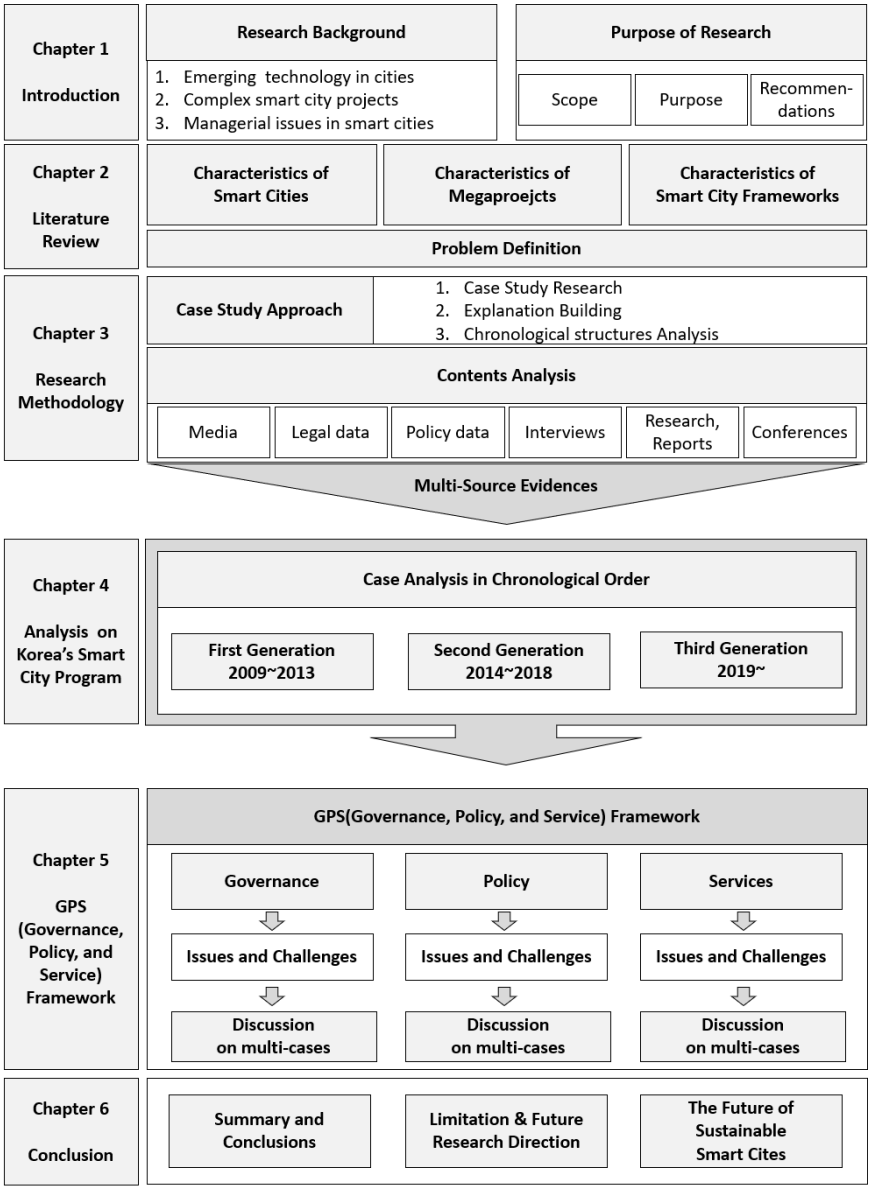

Figure 2: Research Structure

Chapter 2

Literature Review

2.1 Characteristics of Smart Cities

The purpose of a smart city is to provide a platform to assist and serve citizens by linking the city's infrastructure with ICT to pursue economic, environmental, and social benefits [11–16]. An ICT-enabled infrastructure enables smart city initiatives to create the capacity to deliver smart city services to improve citizens' quality of life and increase business opportunities [17–19]. An ICT-enabled infrastructure facilitates services by connecting real-time information to multiple devices [20, 21]. Young Hoon Kwak and Jaehyun Lee [4] argued that a smart city, which consists of physical infrastructure, ICT infrastructure, and services, connects physical locations to cyberspace to enable services for citizens and cities. A smart city also analyzes urban data to provide environmental solutions and economic development [13, 21]. Lately, many cities are pursuing smart cities and providing services in their own way. Smart city strategies vary depending on the economy and level of development. In developing countries, smart cities serve as a vehicle to reinforce national competitiveness and provide solutions to the problems associated with rapid urbanization [22]. Table 2 summarizes numerous definitions of smart cities from a comprehensive literature review.

Table 2: Definition of smart cities

Author	Definition	Reference
Yigitcanlar *et al*. (2018)	Smart city involves a system of systems approach and a sustainable and balanced view on the economic, societal, environmental, and institutional development domains.	[23]
Kondepudi *et al.* (2014)	An innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, and environmental aspects.	[15]
Lee, Phaal, and Lee (2013)	A city that is managed by a network and which supplies its citizens with services and content via the network using both fixed and mobile smart city infrastructure, based on high-performance ICT.	[19]
Alkandari *et al.* (2012)	A city that uses a smart system characterized by the interaction between infrastructure, capital, behaviors, and cultures, achieved through their integration.	[11]

Batty *et al.* (2012)	A smart city is a synthesis of hard infrastructure (or physical capital) with the availability and quality of knowledge communication and social infrastructure.	[24]
Allwinkle Cruickshank, (2011)	Smart cities apply the capacities that recent intelligent cities have sought to develop as the technical platform across a host of service-related domains. The point of emphasis and intervention begins to shift from innovation to application, from the back-office to front-line services, and in policy terms, the emphasis also shifts from the corporate to the civic, from the market to the community, and from the bureaucratic administration of the economy to a liberal democratic governance.	[25]
Lazaroiu and Roscia (2012)	A city model where the technology is in service to the person and to his economic and social life quality improvement.	[18]

Caragliu, Del Bo, and Nijkamp (2011)	The role of smart city initiatives should invest human and social capital, traditional and modern communication infrastructure and emphasize on how it becomes smarter (wise management of natural resources, participatory governance).	[26]
Harrison and Donnelly (2011)	The Smart City provides new instrumentation that enables observation of urban systems at a micro-level.	[27]
Komninos, Schaffers, and Pallot (2011)	Smart cities concept is connected to notions of global competitiveness, sustainability, empowerment, and quality of life, enabled by broadband networks and modern ICTs. Its implementation requires the development of migration paths regarding Internet infrastructures, test bed facilities, networked applications, and stakeholder partnerships.	[28]
Nam and Pardo (2011)	Key conceptual components of Smart City are three core factors: technology (infrastructures of hardware and software), people (creativity, diversity, and education), and institution (governance and policy).	[29]

Bélissent (2010)	A city that uses ICTs to make the critical infrastructure components and services of a city - administration, education, healthcare, public safety, real estate, transportation, and utilities -more aware, interactive, and efficient.	[12]
Harrison *et al.* (2010)	Connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city.	[14]
Hall *et al.* (2000)	A city that monitors and integrates conditions of all of its critical infrastructures can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.	[13]

The success of a smart city program depends on the coordination of various governmental agencies, business, and communities [30] and providing synergies to change the way the entire community benefits from smart city services for long-term sustainability [29]. Therefore, a smart city is not only about adopting technological advancements, but also about understanding socio-technical and political issues [17], governance [29], and civic in-

volvement [8, 20]. For example, the combined efforts of the community and a traffic-management project in Stockholm solved a problem by identifying the various perspectives of private and public stakeholders [31]. The varying elements of smart cities make their evaluation difficult and impede the decision-making process [32]. In pluralistic settings, decision-making requires prolonged communication to reach a participant consensus [33].

The formation of smart city governance in the early stages of planning significantly impacts the maturity of smart city services. A top-down approach can help establish smart city governance in the early stages, while a bottom-up approach can be more effective during growth stages [21]. The top-down approach shows strong leadership in formulating a formal and comprehensive strategy whereas the bottom-up approach coordinates the individual institutions that provide data and services more organically. The value of "smart" is meaningless in cities in which the bottom-up approach does not reflect the needs of the citizens [20]. Smart city development is driven by introducing new technologies, but citizen engagement is more important for urban innovation [34]. In fact, smart city projects with a convergence of various technologies often fail because they do not recognize the role of citizens [35]. Stakeholders in various areas should be recognized first and their insights provided in advance [31]. Therefore, the top-down and bottom-up approaches should coexist in smart city programs to accommodate the needs of many stakeholders and integrate a multitude of technologies [35].

A smart city is highly influenced by policies and institutional components [23, 36] in which companies create new businesses to provide services

based on the needs of the citizens using an ICT platform. Smart cities provide new business opportunities by observing urban systems on a micro-level [27]. Some examples of the potential benefits of a smart city include: 1) reducing traffic congestion by providing real-time traffic information; 2) real-time parking information; 3) crime prevention and response program using surveillance cameras and sensors; and 4) reducing losses due to leakage by monitoring the city water treatment facility. In summary, technology-driven innovation enables the provision of various services that improve the quality of life of its citizens and create business opportunities. The technology driven innovation enables various services that creates many new job opportunities. However, a more managerial, policy, and service related issues besides technology adaptation and implementation need to be discussed further.

2.2 Characteristics of Megaprojects

A megaproject is defined as a project that costs over 1 billion USD [37] and is long in duration [38]. Megaprojects contribute to local employment, industrial restructuring, and regional image [39]. Megaprojects often becomes a test of for technology and innovation [38, 40–42]. However, uncertainty in technology makes it difficult for the project initiator to meet the project's goals or objectives [42–44]. In addition, the adoption of unprecedented technologies has created challenges in the areas of cost increases, schedule extensions, safety, health, and the environment [38]. Therefore, the adoption of technology and the value of future technology utilization should be carefully reviewed in megaprojects [44].

As a society matures, political, economic, and social issues affect a megaproject as it becomes more complex [33, 45]. In the 1930s, a consortium of six companies had to be formed by the Hoover Dam project to meet the political and economic challenges and successfully achieve the largest megaproject of its day [46]. The Korean High-Speed Railway project had to be redesigned and was frequently interrupted due to its complexity among the participants and stakeholders [41]. Songdo International Business District in South Korea had a weak governance structure and the participants had to make frequent adjustments due to changes in the internal and external environment [45].

The involvement of various stakeholders can also lead to problems such as social conflict arising between internal and external organizations and strong public resistance [47, 48]. Peerasit Patanakul *et al.* [49] argued that

poor performance on megaprojects is due to the large number of stakeholders, weak project organizational structures, uncertain governance structures, and communication issues associated with competing interests.

Government-led megaprojects sometimes have trouble meeting project goals and objectives. Bent Flyvbjerg [43] argued that megaprojects are often led by government-designated heads with little experience in large-scale projects. In the 1974, Chanel Tunnel project, regime changes negatively impacted the project and the over-dominance of the government led to inefficient project management [42]. Legislators and ministers have also been found to have a relatively short-term view [49].

A change in authority might lead to a change in responsibility, a reduction in assistance, or an interruption in the project [43]. In South Korea's high-speed rail project, several local governments were forced to move the stations to their backyards, causing delays in site acquisition. These political risks had a greater impact on project delays than technical and managerial issues [41].

Megaprojects are prone to political influences that can affect project performance whenever there is a change in regime [49]. In government-related megaprojects, even if a cost overrun occurs due to an execution problem, it is usually difficult to stop the project. Doing so might seem to be an admission that their system is flawed, so even if it requires additional cost, completing the project will remain the main goal. Table 3 summarizes the key characteristics and issues of megaprojects that could be applied to smart city development.

Table 3: Characteristics and issues megaprojects

Characteristics	References	Issues	References
Over 1 billion USD Long in duration	[37] [38]	Delays, cost overruns, scope and ambition level changes over time	[37,38]
Industrial restructuring and regional image	[39]	Political, economic, environment, safety, health and social issues	[33,38,45]
Test of for technology and innovation	[38,40–42]	Uncertainty in technology Non-standard	[42–44] [37]
Various and large number of stakeholders	[41,47,48]	Uncertain governance structures Social conflict, public resistance Weak project organizational structures Communication issues with competing interests	[45,49] [47,48] [49] [49]

Government-led mega project	[43]	Government-designated heads with little experience in large-scale projects	[43]
		Regime chages	[42, 49]
		Short-term views from legislator and ministers	[49]

2.3 Review of Smart City Frameworks

The interest in smart city research has increased exponentially since the 2010s [50] and different smart city frameworks have been explored. Most cities follow processes intuitively rather than implementing a well-structured process [51]. The smart city framework can help stakeholders overcome confusion over new technology [51]. A smart city's overall framework can provide a tool as well as information that will help policymakers and stakeholders make better decisions for citizens [52].

Other studies related to the smart city framework include research from technical, managerial, and organizational perspectives. In terms of technology, IES-City Framework [52] developed a framework to incorporate various stakeholder perspectives for successful technology implementation.

Máté Szilárd Csukás and Roland Z. Szabó [53] applied an existing analytical approach to identify five factors that hindered smart city maturity. As identified from the supplier perspective, these barriers included knowledge gaps, a shortage of experts, access to data, quality of data, and a lack of standards and policies. Since the smart city is a newly emerged city, policies, standards, and experts are currently lacking. In addition, a lack of standardization for smart city development creates further confusion among stakeholders [52].

In this uncertain environment, Gordon Falconer and Shane Mitchell [51] argued that forming a feedback loop in the smart city development process will enable the continuous identification of best practices and allow policy to be supplemented.

Previous studies on the smart city framework can be divided into the technology-oriented and management-oriented perspectives. There are frameworks from a technical point of view that provide feedback on smart city services [50], research interdependence between services and an ICT infrastructure [54], and a framework that enables stakeholders to make optimal decisions before the deployment of technology [52].

In the management-oriented research, Hafedh Chourabi *et al*. [36] developed a framework for explaining the relationships and influences between eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment. Gunjan Yadav *et al*. [55] developed a framework based on 31 enablers for the successful execution of smart cities, and demonstrated that supportive government policies, advanced ICT, and the adoption of innovative construction technologies were the foundation of smart city projects.

Based on interviews with experts from Seoul and San Francisco, Jung Hoon Lee *et al*. [21] designed a holistic framework that included institutional elements and technical perspectives with six key aspects: urban openness, service innovation, partnership formation, urban pro-activeness, smart city infrastructure integration, and smart city governance.

Chapter 3

Research Methodology

3.1 Case Study Approach

This study used a case study approach [56] [57] to investigate the issues and lessons learned from smart city cases by investigating previous literature and observation from past experience. Deductive qualitative content analysis [58] [59] [60] was utilized to discover patterns of argumentation regarding smart city projects. Specifically, this study extracted the key factors of smart city programs, analyze cases in a chronological order, and propose a smart city framework for future debates. Cross-checking was performed to determine if problematic issues occurred in other smart city and megaproject cases. Figure 3 illustrates the overall research approach used by this study.

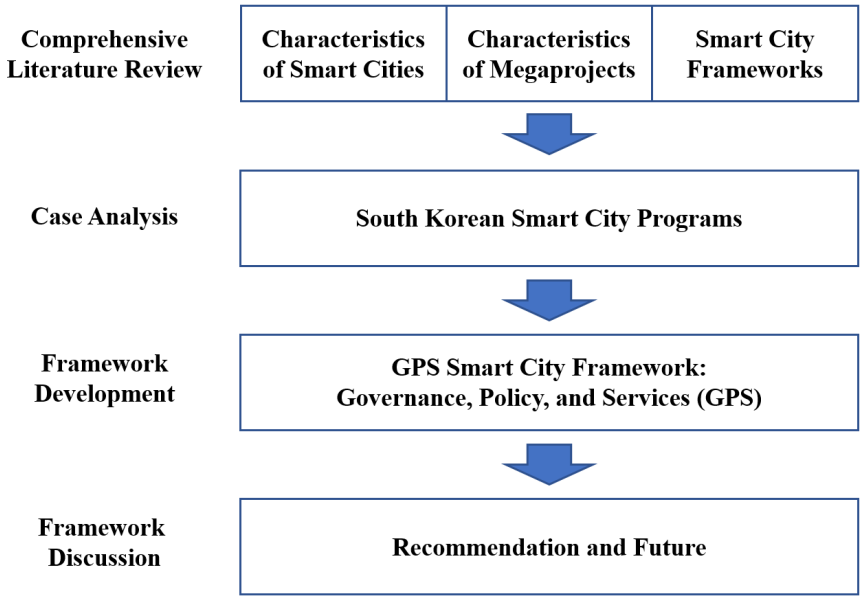

Figure 3: Research Approach

3.2 Data Collection

To collect comprehensive data, this research used various sources of information [60]. Table 4 shows Source data list. Since all of South Korea's smart cities are national programs, many primary and secondary data are publicly accessible. This study used "gray data" to improve the quality of these data [61]. The author conducted five informal interviews with smart city project planners, operators, and construction managers. The author attended conferences to collect practical smart city experiences.

Table 4: Source Data for a case analysis

Data Type	Material	Number
National Policies	National Smart city Master Plans	3
Municipal Policies	Smart city plans by local government	24
Legal documents	Act on smart cities	3
Media	News articles	54
Interviews	Informal Interviews	5
Conferences	Conferences data	5

In addition, specific case data related to smart cities were collected from media sources. Those articles were extracted using BigKinds, a big data analytical service run by a Korean press foundation. Using manual and portal search terms such as "Smart city" and "U-City," approximately 36,000 articles from 55 media outlets were identified from January 1st, 2003 to December 1st, 2019. Figure 4 shows burgeoning interest in smart cities. Then, smart city-related articles were manually extracted and further characterized. After analyzing all identified primary and secondary data, gray data, and articles, they were classified into three categories: governance, policy, and services. In the end, results of this research align with other smart city

and megaproject cases to discuss the future of sustainable smart cities.

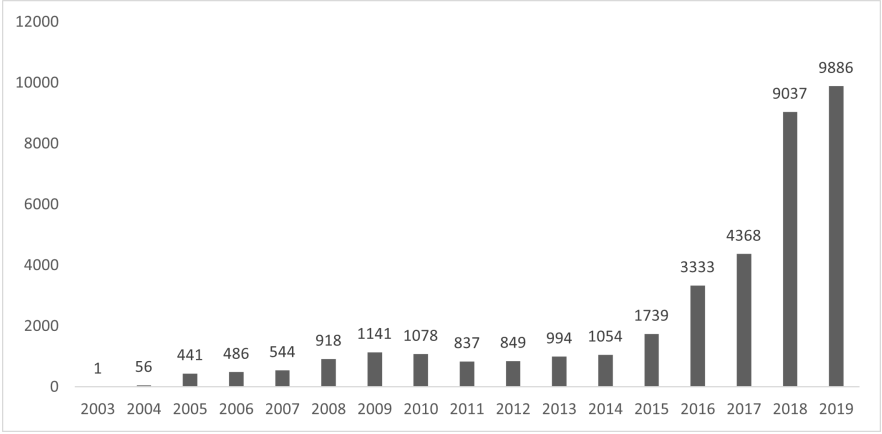

Figure 4: Numbers of news articles regarding smart cities (including U-city) in South Korea (Data source: [3])

Chapter 4

Three Generations of Korea's Smart City Program

4.1 Overview

In 2008, South Korea's smart city program began with the first "Ubiquitous City" (U-City) Construction Act. Since the first smart city master plan was announced in compliance with the U-City Construction Act in 2009, the Korean government has renewed a smart city master plan every five years.

Smart city programs in South Korea are in their third generation as of 2020. Table 5 summarizes the evolution of the national initiatives implemented by South Korea's smart city program. Throughout the three generations, planning, construction, and management problems have been ameliorated. When it comes to business area of Korea smart city program, in the first generation, only the construction of a new city was included in the business area, but the second and third generations expanded the scope to the existing city as well as the Shrinking City (see Figure 5).

Table 5: Smart city generation of South Korea adapted from 3rd Korean Smart City Master Plan [4]

Classification	**First generation (2009 ~2013)**	**Second generation (2014 ~2018)**	**Third generation (2019 ~)**
Goal	Cultivate new growth in the construction and information and communication industries	Low-cost and high-efficiency services	Urban problem solving Fostering innovation Ecosystem
Information	Vertical data integration	Horizontal data integration	Interoperability
Platform	Closed (silo)	Partially open	Partially open (expendable)
Institution	First U-City Master Plan	Second U-City Master Plan	Third Smart City Master Plan
Subject	Central government	Central government + Local government	Central government + Local government
Object	New town (bigger than 1.65 million square meters)	New town + existing city	New town + existing city
Characteristics of Business	Building physical infrastructure	Platform building	Innovation system
Approach	- ICT infrastructure Sensors, CCTV, communication network, gateways, antennae, etc. - Physical infrastructure Transportation, housing, space, distribution, supply, cultural and sports public, commercial, disaster prevention, health hygiene, environmental foundation	-Institutional integration -Standardization promotion -Organization integration -Functional integration Establishment of public integrated platform and securing compatibility	-Discover and spread services -Develop a national pilot smart city -Legal/system revision cooperation system -Performance diagnosis -Promotion of various contests.

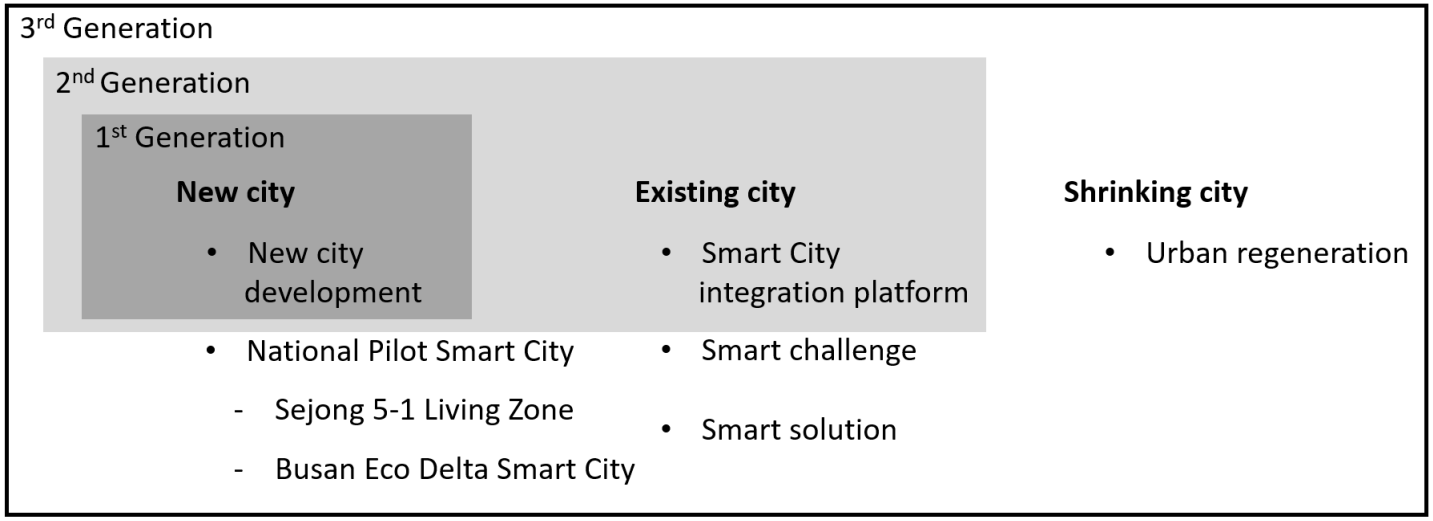

Figure 5: Business area of the Korea smart city program (Source: https://smartcity.go.kr)

The illustrative issues in the first and second generations were that the central government dominated smart city programs and the city data were not open access [4]. In addition, it was difficult to integrate new services into smart city programs other than those stated in the government guidelines. Eventually, in the third generation, the U-City name was changed to "smart city" to overcome the challenges associated with the U-City program.

Smart city services comprise both the public and private sectors. In the early days of South Korea's smart city program, trying to provide public services without input from or reflecting the needs of the citizens and cities was a problem [62]. Public services were defined and classified by the policy maker and the entire services were supposed to be run by local governments. Specifically, 11 service guidelines were suggested from the government. 1) Administration, 2) transportation, 3) health care and welfare, 4) environment, 5) crime prevention and disaster prevention, 6) facility management, 7) education, 8) culture, tourism, and, sports, 9) logistics, 10) work and employment, and, 11) others that are not included in the guideline but are services that can provide convenience to users for building infrastructure [63]. In reality, most smart cities operated very few public services such as traffic management, crime prevention, and facility management [5, 64] (see Table 6).

In the Korean smart city programs, about 97% of the project budget was allocated to traditional construction infrastructure whereas only 3% of budget was appropriated for ICT infrastructure and service operations and management (O&M) [4]. The data also revealed that the estimated annual operating and maintenance costs were about 10% of the ICT infrastructure

Table 6: Smart city planning and actual service ratios based on five smart cities [5]

Service classification	Traffic	Crime prevention	Health, medical treatment, welfare	Culture, tourism, sports	Environment	Education
Planned service	12.2%	12.2%	10.5%	10.5%	8.8%	7.9%
Actual service	32%	35%	3%	3%	7%	1%
Service classification	Facility Management	Employment	Logistics	Administration	Other	
Planned service	7.9%	5.3%	4.4%	8.8%	11.4%	
Actual service	10%	9% (including employment, logistics, administration, and other)				

costs, but they often failed to fully operate because not enough of the budget was allocated to various services [4].

South Korea smart city programs are still plagued by many challenges. First, a long-term successful smart city model has yet to be introduced. Second, the improvement of smart city services has been limited. Third, smart city services have fallen short of citizen expectations [62, 65].

4.2 First Generation (2009 ~ 2013)

South Korea's smart city was promoted in connection with the Housing Site Development Promotion Act. For housing development, a project entitled "U-City" began integrating ICT into the city, but the project's organizational structure followed traditional urban development. As a result, there were conflicts among the ministries as opposed to close collaboration.

The U-City programs were partially led by three ministries before the first act on U-City construction—the Ministry of Information and Communication (MIC); the Ministry of Land, Transport, and Maritime Affairs (MLT); and the Ministry of the Interior and Safety. Due to a lack of consensus among the different ministries, it took more than eight months to legislate the first U-City construction act.

There were also many overlapping responsibilities among the ministries that resulted in confusion. Furthermore, each ministry only promoted their own interests. The MIC established the U-City Association, which focused on system integration and information technology companies, whereas the Korea Land and Housing corporation (LH), which is an MLT-affiliated public company, established the U-City Forum, consisting of construction and civil engineering companies. The U-City Association and U-City Forum often blamed each other for problems and neither organization pursued amalgamation. At the end, MLT was designated as the head of the smart city project and established a U-City committee to coordinate projects. Unfortunately, conflicts between the project operator and the local government were never resolved and the committee's act on mitigation was ultimately

not observed.

South Korea's smart city model provided integrated service solutions developed by the national organization after the implementation of large-scale urban infrastructure development. This approach is also observed in other Asian countries such as China and India. Conversely, in Europe and the United States (US), the focus is on solving urban problems first and then finding a way to integrate the system [66].

In the case of South Korea, LH, a public company and the main smart city operator, built the physical and ICT infrastructure for the smart city and planned to hand it over to the local government. However, the management of the ICT infrastructure and services became unsettled after the completion of the smart city [64, 66]. LH was considering handing over the services at the time of completion, but the local government kept delaying the acquisition of services. This was due to the operating expenses incurred after the receipt of the smart city operating rights. The local government feared that a backlash might occur if the operation costs were passed on to the citizens. LH ended up subsidizing some of the O&M expenses to hand the O&M over to the local government [4].

There were instances in which another project attempted to subsidize the operating costs in the region by inflating land prices in consideration of future compensation of the local government's operating costs. There was also confusion between the local government and the LH regarding who would pay for the construction of the comprehensive information center in the smart city.

The basic law of the smart city was enacted to effectively manage ser-

vices, promote collaboration between government departments and local governments, prevent overlapping investments by business, and accelerate efficient city management and smart city projects. However, the first Korean smart city construction act, the U-City Construction Act, fell short of expectations. There was no clear definition or concept of a smart city, no standard guideline for technology adoption and services, no clear legal interpretation of overlapping investments, and no identified entity to operate and manage smart city services [64]. In addition, the legal foundation of the business model was insufficient and the legal basis for financing services was not established. This made it difficult to encourage private sector involvement for revenue generation. Most services were public and most local governments, aside from those of Hwaseong, Paju, and Busan, decided not to implement smart city services without a budget.

In summary, the government planned to provide a comprehensive service, but concerns persisted about the differences in the services of smart cities provided by regions due to local government repercussions. Of the 250 services supported by government funding in the first generation of the smart city program, only 50 services were operational until the end of the first generation because of the absence of a responsible organization in each local government and a lack of consideration regarding the financing of system maintenance [66]. In addition, the implementation of new services restricted private sector involvement, which caused many problems. The smart city project required a major paradigm shift, but there were significant restrictions that hindered the development of smart cities.

4.3 Second Generation (2014 ~ 2018)

Since the new smart city development model based on the Housing Site Development Promotion Act was no longer expanded, the second generation focused on changing policies regarding information and system integration [67]. The smart city initiative that was only for newly built cities was expanded to include transforming existing cities. In existing cities, an integrated urban control center was introduced to assimilate various services such as traffic and crime prevention, but the integration of different services was impossible without an innovative approach to interweaving a variety of organizations [67].

During the transition from the construction of the smart city to its operation, the liaising and cooperation of ministries for its service and operation continued to be insufficient [66]. The strategy for constructing a smart city infrastructure in relation to the Housing Site Development Promotion Act led to tangible results, but the service and operation strategy was still lacking. Most smart cities provided only basic public services such as transportation and crime prevention based on the service guidelines provided by the central government. As a result, only 17 out of 108 local governments had an independent department to manage their smart city [66].

In addition, the South Korean government changed twice during the second-generation smart city program. When a new administration came to power, the existing departments involved in smart city projects were dismantled and new ones established. This greatly influenced smart city policy and legislation. As a result, the driving force behind the smart city initiative

was weakened and the supporting budget greatly reduced. Consequently, the absence of smart city program control towers prevented the government from actively coordinating conflicts between multiple stakeholders such as local governments, project operators, and departments.

Citizen engagement is often essential in the successful implementation of a smart city to improve citizens' quality of life. However, first- and second-generation smart cities in South Korea had no gateway for accommodating citizens' opinions. This is because there was no voluntary participation by companies and citizens. The smart city was supposed to attract private investment, but there were no strategies or budgets to encourage the investment of private capital. The smart city program continued to focus on the planning and execution phases and put less emphasis on their operation and maintenance.

4.4 Third Generation (2019 ∼)

Since 2017, the Korean government has propagated the national pilot project of building a futuristic and innovative smart city in two regions—the Sejong Administrative City and the Busan Eco Delta City. The current state of government-driven pilot smart cities are presented in Table7.

Table 7: The Current State of Government-Driven Pilot Smart Cities in Korea [5]

Project Title	**Sejong 5-1 Life Zone**	**Busan Eco Delta Smart City**
Cost/ Duration	1.2 billion USD/ July, 2018˜2022	1.8 billion USD/ July, 2018˜2023
Planned Area	2.7 km^2	2.2 km^2
Operator	LH (Korea Land and Housing Corporation)	K-Water (Korea Public Water Management Company)
Vision/ Philosophy	City as a sustainable platform to enhance civic satisfaction and provide creative opportunities	Bring forward futuristic living in which nature, people, and technology come together
Three Innovations	- Happy citizens - Sustainable city - Creative opportunities	- Process innovation - Technological innovation - Governance innovation
Key Challenges	- Seven Innovation Services 1) Mobility 2) Healthcare 3) Education 4) Energy and Environment 5) Governance 6) Culture and Shopping 7) Job opportunities	- Three Focused Strategies 1) Smart Tech City 2) Smart Water City 3) Smart Digital City - Seven Main Contents 1) People-oriented smart city 2) Citizen engagement 3) Living network 4) RD plug-in city 5) Regulatory sand box 6) Big data and open data city 7) Smart 4th Industrial Revolution technology

The Sejong project consists of interactive services for citizens such as autonomous driving and shared mobility, healthcare, and education, along with a spatial plan that is optimized for the "Seven Innovation Services" mobility, healthcare, education, energy and environment, governance, culture and shopping, and jobs. The Busan Eco Delta Smart City focuses on developing proposals on smart water management and on "Five Innovative Clusters" for fostering new industries related to the fourth industrial revolution.

In the third generation of the Korea smart city program, master planners were appointed to comprehensively manage two national pilot smart city projects in Busan and Sejong. According to the Master Planner Act, the master planner's scope is from the initial stage of the smart city through the completion of construction, so the master planner plays an important role in the integration and management of the physical infrastructure with the ICT infrastructure. In addition, Young Hoon Kwak and Jaehyun Lee [4] recommended an entity or special purpose company be designated to provide sustainable service over the entire smart city life-cycle.

In traditional urban planning, decisions propagate vertically downward from Korea's Ministry of Land, Infrastructure, and Transport through municipal governments down to project operators, as shown on the left side of Figure 6. This facilitates and simplifies communication between actors, but cannot encompass the multiple public and private actors involved in the decision-making process. A smart city, on the other hand, cannot help but pursue a horizontal decision-making structure to integrate new decision-makers and reflect the needs or interests of the various stakeholders, in-

cluding the citizens. Prominent features are (1) the inclusion of the master planner to address the coordination issues observed in U City projects and (2) the participation of an external expert group due to the important functionality of smart city technologies.

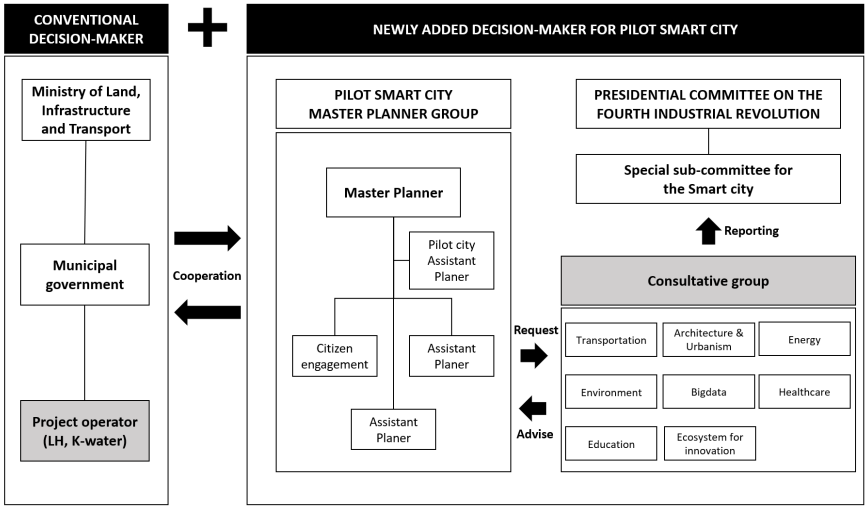

Figure 6: The Structure of the National Pilot Project for the Smart City [1]

Even in the third generation, smart city services were hindered by regulations. For example, due to the Software Industry Promotion Act, the participation of large companies in the public software (SW) market was limited. The purpose of the act was to foster the development of small and medium-sized enterprises (SMEs), system integration companies, and SW companies and encourage large companies to target overseas projects. Including the participation of large companies that possessed the technology and resources for advanced services would have been critical. However, under the Software Industry Promotion Act, bidding from large corporations was restricted on all smart city projects. In addition, some smart city services

should be able to provide customized services by analyzing massive data. However, due to the act on privacy protection, the use of personal data was extremely limited. As a result, there was a growing demand for deregulation that would enable the use of personal, financial, healthcare, and educational data.

According to the pilot smart city plans and interviews of project operating groups, various decision-makers participate in the projects. This will most likely cause some difficulties in communication and decision-making processes. To address this issue, having a project manager who can manage and direct various organizations is required. Considering the importance of smooth coordination between the various stakeholders, the authorities should establish a special organization that can orchestrate various stakeholders while dispatching competent professionals to engage in decision-making processes and stakeholder communications.

Attempts have been made in each way to this coordination issue in the management process. The project operator (LH) of Sejong 5-1 Life Zone established a new organization for interorganizational coordination and dispatched its professionals to engage in the communication and decision makings among the new organizations.

In the Busan Eco Delta City, the project operator (K-water) itself coordinates and manages the project. As more smart city cases emerge, it will become increasingly important to evaluate the effectiveness of various approaches to smart city project management.

Among the 21 services supported by the Ministry of Science and Technology, nine services were never in operation. Government agencies devel-

oped various services and transferred them to local governments and SMEs; however, the services were not managed or monitored well. There was also a lack of guidelines for connecting content and other providers of smart city services. The city planned to operate an integrated city operations center to link services but failed to do so because of a lack of guidance from the government.

Chapter 5

GPS (Governance, Policy, and Services) Smart City Framework

5.1 Introduction of the GPS Smart City Framework

Previous smart city frameworks emphasized connection and integration among the various initiatives and stakeholders. In this study, a sustainable smart city framework to promote a successful smart city program was proposed, applying the lessons learned over 20 years of South Korea's smart city program.

This study proposes a sustainable GPS Smart City Framework (see Figure 7) that incorporates governance, policy, and service to address the following three fundamental questions. What governance structure is ideal for a smart city? What policies will facilitate the application of a smart city? What services should be considered that can meet citizens' needs? What strategies exist for the long-term sustainability of smart city operations? Young Hoon Kwak and Jaehyun Lee [4] argued that a smart city consists of three layers-physical infrastructure, ICT infrastructure, and services. These three layers are the foundation of our framework.

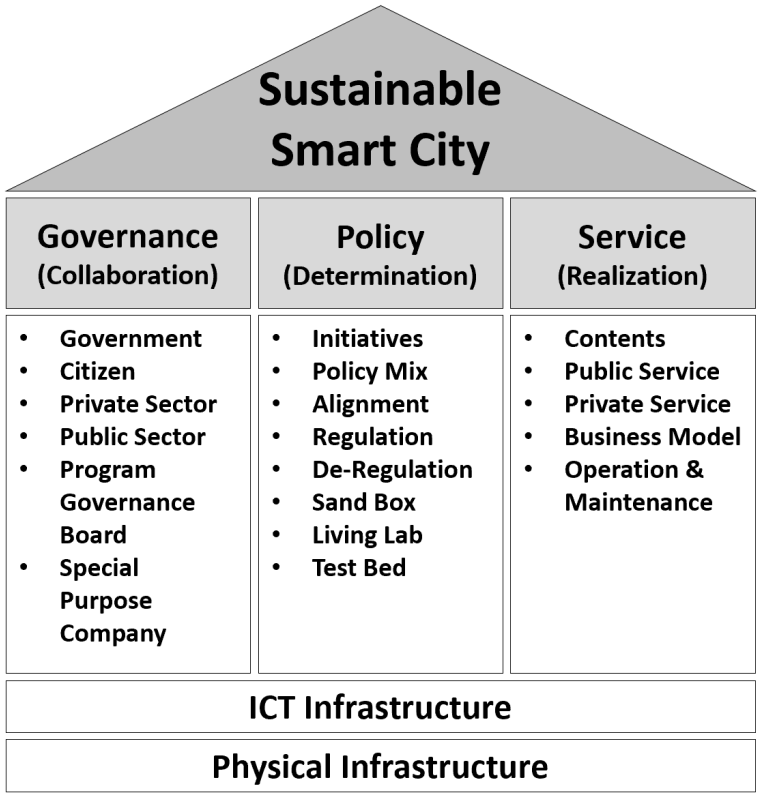

Figure 7: GPS (Governance, Policy, and Services) Smart City Framework

5.2 Discussion on Smart City Governance

Governance is a major challenge in smart city planning and operation [68]. A smart city is a space in which various industries and government agencies become intertwined. In the public sector, numerous ministries and construction-related government agencies participate as stakeholders. In the private sector, companies from a variety of industries participate in addition to construction companies. As a result, governance-related issues are very complex and the decision-making process is often extremely difficult.

During the early generations of the South Korean smart city program, the main governance problem was the absence of a control tower. South Korea used a typical top-down, hierarchical structure, but it was difficult to establish devoted governmental leadership due to conflicts among the various government ministries. In fact, similar organizations with overlapping responsibilities were created to support government ministries, which resulted in confusion and failure.

To successfully build a smart city, establishing a program governance board (PGB) is essential to implementing and managing the smart city's development and execution. Nuno Gil and Jeffrey K. Pinto [33] supported the need for an umpire system that was external to the polycentric system to mitigate and judge local project disputes. PGB could also play the role of an umpire of a smart city program in which various policies and organizations converge. Most smart cities have established a special venture or an organization that plays the role of PGB to manage and incubate smart city initiatives [69]. For example, in the case of Smart Columbus, the pro-

gram management office managed the entire Columbus team including the partners, participants, stakeholders, and the US Department of Transportation [70].

Smart cities also require subject-matter experts and leadership to jointly coordinate the efforts of various stakeholders. For example, the cooperation of various ministries was important in the Barcelona Smart City initiative. To make this possible, a Barcelona agency acted as an intermediary, providing a clear definition of inter-ministerial collaboration and the project scope for economic development [9]. In San Francisco, the Mayor's Office of Civic Innovation introduced an innovative organization that could be more collaborative, creative, and responsible and provide an exemplary approach to smart city construction in 2012 [9, 21].

In the case of the Hoover Dam, a pan-governmental project team with joint public-private partnerships was required on the project level, so the joint venture was the organizational innovation of the time, created to integrate various challenges and technologies [44]. It was not an advisor, but an entity, that was put in charge of the life-cycle of the project. If a public-private project team is formed, the organization should oversee smart city governance. This will reduce political risks and involve private sector participation. The smart city program is a complex endeavor in which different players are involved, advanced knowledge is integrated, and, as a result, various legal issues arise. Due to the characteristics of the complex project environment, it could be difficult to evade the influence of regime change. Instead, the organization needs to integrate diverse opinions to demonstrate leadership. To effectively respond to the various agendas of political stake-

holders, providing authorization to a project leader [49] is necessary. Table 8 summarizes the issues and challenges related to smart city governance.

Table 8: Smart city governance issues and challenges

Category	Issues and challenges
Control tower	Conflicts between a business operator and local government Conflicts between ministries Conflicts between business operators and the municipal government Integration of government agencies for the smart city The need for a pan-governmental organization
Role of the government	Government-led organizational structure Governmental indifference Risks due to government changes Lack of citizen participation

5.3 Discussion on Smart City Policy

Megaprojects are associated with many legal problems that require tremendous effort to solve [33,45]. Smart cities are broadly affected by policies and legislation since they cover a wide range of issues, are involved in many different ministries, and require various laws to develop and operate. Therefore, cross-organizational integration across different ministries is an important element of smart city initiatives in terms of policy-making and legislation [17].

Korea's Smart City Act was steadily revised and improved since its first implementation in 2008. The initial policy direction of South Korea's smart city program was the concept of providing a public service by integrating an ICT infrastructure with an existing city without understanding the service components of the smart city. However, there is a lack of innovation in the laws related to smart cities. Smart cities have had many difficulties in pursuing new businesses due to strict regulation from existing laws.

Policies and laws related to the smart city tend to be taken from the government's point of view and lack an important element—citizen participation. For example, South Korea plans to conduct a regulatory sandbox experiment because it is time consuming to amend regulations. When a business operator requests a special case for new technology, the relevant ministries temporarily approve the case after reviewing the conditions and reorganize the regulations during a trial period. The regulatory sandbox will be piloted in the national pilot smart cites, the Sejong 5-1 Life Zone and the Busan Eco Delta Smart City.

The provision of consistent services by the government hinders the entry of new technologies. Previous smart city projects often failed because the services of the smart city were driven by the public sector and did not consider a business-driven model that provided long-term services. The Smart City Act in Korea was, therefore, established with the aim of contributing to people's lives and balancing national development by promoting efficient construction and management of the city, fostering the competitiveness of cities and sustainable development.

In South Korea, accelerating the implementation of the smart city program as a national initiative to develop new cities with rapid promotion and consistent services was possible. In addition, in conjunction with the existing housing site development law, ICT infrastructure was added to the existing urban plan. However, after citizens moved in, it was criticized as just a public relations scheme because it was difficult to distinguish between the existing city and the smart city. On the contrary, in Montreal, the leadership of local ICT SMEs and the world's leading companies took a symbiotic and competitive bottom-up approach.

Frequent changes in government organizations make it difficult to expect long-term political commitments [31]. To better provide new services in the smart city initiative, preparing a smart city initiative by breaking down existing legal and regulatory barriers is necessary [36]. Table 9 lists the policy-related issues and challenges in smart cities.

Table 9: Smart city policy issues and challenges

Category	**Issues and challenges**
Guideline	Policies that do not reflect regional characteristics Lack of a legal basis for a business model Lack of local government policy Lack of a unified plan
Regulation	Legislative delay due to conflicts between ministries Negative effects of government regulations Government-led project with limited private company participation Prevention of new technologies due to government regulations

5.4 Discussion on Smart City Services

The provision of smart city services requires a steady stream of revenue to cover operating costs. If public taxes are levied to finance the operational costs of smart cities, citizens will question whether the services that they receive are useful and, if not, question charging additional taxes.

The lack of a business model for the smart city's future operation is a major limitation of the program. Conventional cities have a one-time sales model wherein a developer provides a construction infrastructure. To generate the revenue required to sustain smart city services, the business model needs to induce corporations to participate. Aside from the fact that the majority of SMEs moving into smart cities seek lower rents and government-funded incentives, there is a lack of incentives to attract companies to smart cities. Smart city projects in public tenders were often for small-scale ICT implementation. This implies most smart city programs end up applying more limited technology than they originally intended to adopt.

Smart city service issues can be divided into three different elements which are the business model, the service content, and O&M. Each city provides consistent services, which are mainly public services. Therefore, it is difficult to expect the active engagement of private companies because they cannot provide services without generating revenue. Although attempts were made to consistently provide smart city services in the form of total packages, the results often lacked citizen and corporate participation.

Taxes are often used to finance smart city public services [71]. The O&M costs of public services are usually not considered in detail during the

smart city planning stage, which results in revenues from smart city services falling short of O&M costs [4]. Therefore, the local government provides partial services. Consequently, each city only provides public services that are indistinguishable from conventional cities.

There is a need to change the perspective on the provision of services. Creating a platform that can continuously provide services that meet and exceed citizens' expectations and requirements is necessary. Cities should pursue a social product development platform [72] that enables open innovation and that can be sustainable beyond the limited space of a test bed. Open innovation represents a scheme for knowledge-sharing and collaboration [73] and enhances an organization's ability to solve problems [74].

The system for incubating smart city services is termed "Living Lab." Pieter Ballon *et al*. [75] defined the Living Lab as "an experimentation environment in which technology is given shape in real life contexts and in which (end) user are considered 'co-producers'. The Living Lab is a physical and institutional space in which products can be tested at an intermediate stage to quickly understand market feedback [76, 77]. The Living Lab represents collaboration and experimentation and will provide an opportunity for the development of new businesses models. Currently, Living Labs operate in Barcelona, Helsinki, Catalan, Botnia, Amsterdam, and other European cities [76,78]. In Living Labs, many professionals who do not have a job are free to collaborate and strengthen their networking skills while reducing the cost of running their own businesses [35]. The scope of the Living Lab was introduced in the range between the market pilot and prototype [79]. Market pilots are time consuming because of the high level of technical maturity

and prototypes are not mature enough to be tested in the actual market [75].

However, the implementation of a Living Lab is difficult and challenging. An open innovation system could encounter a challenge in attracting participants [73]. In the urban smart energy campus "European Energy Forum" (EUREF), a regulatory free zone was applied to secure regulatory flexibility, but citizen participation was insufficient [80]. Unlike the EUREF, the rural renewable energy network "Energy Avantgarde Anhlt" established governance in which citizens could participate, but failed to attract citizens because they tried to solve national problems in the city, not the problems of the city itself [80].

The active participation of the citizens is essential to revitalize the Living Lab and citizen data can be actively used for urban development. This reduces the negative risks to business and to the citizens of social structures through the organic interaction of the citizens with the cities. For example, in selecting the responsible department for the Smart City Challenge task, Amsterdam's Startup-in-Residence Program (SiR) encountered difficulty when it was applied to more than a single department. The responsible department underestimated the task and provided limited time and effort. Data and project ownership also became major issues between the supporting department and the startups.

Therefore, policy intervention is a prerequisite of the Living Lab. When recruiting groups to participate in new technological development in a Living Lab, people with specific characteristics can gather, so considering whether citizens participating in a Living Lab are comprised of the user groups that reflect society is required. Pieter Ballon *et al.* [75] argued the factors that

hindered continued public participation include a lack of systematic monitoring and evaluation of their activities and outcomes. In case of the SiR, there a support structure to scale up items and startup competence were lacking and no department existed to purchase new solutions [78].

In Korea, a Living Lab will be carried out in the national pilot smart city of the third-generation smart city program. Entrepreneurs might be attracted to the innovative platform with benefits such as low-cost facilities, business services, and opportunities [81]. However, Cesar Bandera and Ellen Thomas [81] argued that social capital is not correlated with startup survival. Even though there is a concern that only entrepreneurs who want to benefit from the move-in are participating, it is expected to be an innovative platform to foster sustainable services. Table 10 describes the issues and challenges of smart city services.

Table 10: Smart city service issues and challenges

Category	Issues and challenges
Business Model	Lack of strategy and budget to attract company capital Need for a sustainable business model Need to develop a new business model One-time business model like common construction projects Participation of a private company
Contents	Excessive facility installation for U-City services Lack of guidelines for interoperability with services Lack of information security Less services than planned Services with low citizen satisfaction
Operation & Maintenance (O&M)	Operating expenses increase due to the suspension of governmental financial support Poor operation of new services Refusal to takeover a U-City facility

Chapter 6

Conclusion

6.1 Summary and Conclusions

This study analyzed Korean smart city programs using primary and secondary data regarding smart cities. Specifically, we were able to secure secondary data because the country has been carrying out smart city programs as a national initiative. Additional case reports, internal data, and interviews with stakeholders provided a comprehensive view of Korean smart city programs over the last 20 years. This study proposed GPS as the three pillars of a sustainable smart city framework.

The findings of this case study research answer our research question "What are the essential characteristics of a successful sustainable smart city beyond technology adaptation and implementation?". First, the Smart City Master Planner and Project Governance Board are key to the success of smart cities. By understanding the characteristics of the smart city, they can integrate and coordinate the complexities and challenges of various elements, stakeholders, and projects. Second, regulatory innovation can revolutionize smart city services. As the variety of services increases, the adoption of innovative smart city legislation will also be a key factor for creating long-term, sustainable smart cities. Third, it is critical to provide services that reflect the ideas and demands of citizens rather than to provide a ser-

vice in a packaged form that often fails in action. Every city and country have a different problem and because citizens are the entities that receive the various services, every smart city must be able to be offer and operate long-term services. Table 11 presents the main recommendations based on the GPS smart city framework.

Table 11: Summary of research recommendations for sustainable smart cities

Category	Recommendations
Governance	Establishing a program governance board (PGB) Providing authorization to a project leader Deployment of umpire system to mitigate and judge local project disputes Establishing Joint public-private partnerships
Policy	Cross-organizational integration across different ministries Breaking down existing legal and regulatory barriers
Service	Pursuing a social product development platform that enables open innovation Living Lab for a physical and institutional space in which products can be tested in real life contexts to quickly understand market feedback To solve problems that citizen needs To solve data and project ownership Systematic monitoring and evaluation of activities and outcomes

Most of the new cities will be built as smart cities or will have elements of technological application. The lessons learned from this research can be applied to developing countries that have similar social and economic environments that are considering or planning to develop smart cities. For example, Malaysia's Kota Kinabalu Smart City, Myanmar's Dala New Town Smart City, Vietnam's Mekong Delta Smart City, and Indonesia's new capital smart city can adopt the GPS smart city framework that this research proposed. The initiatives of smart cities all over the world could lead to greater opportunities and this study contributes by identifying essential characteristics of smart city beyond technology that are essential for future smart city development and operation.

6.2 Limitation & Future Research Direction

This study conducted a case study of a holistic approach to a 20-year project in Korea. Korea's national smart city programs and implementation details were reviewed by collecting multi-evidence from various sources at the program level. Future smart research should utilize the GPS framework to analyze individual projects and verify the elements of the framework with project level.

The smart city programs are divided into three level: national level programs, local government level programs, and city-level smart city projects. In this study, the national and local level plans were analyzed, but the city-level smart city plans were not reviewed. According to the Korea Act on smart city construction, the aforementioned plan for each level must be ap-

proved before the execution of smart city projects. However, in the case of the city-level smart city plan, the smart city project which is already underway were exempted from the plan in terms of an exceptive clause.

This study reviewed and analyzed Korea's smart city cases primarily from the national and local government point of view. However, municipal and city level smart city projects were not reviewed in detail. There would be different factors and motivations to transform the existing city to smart city from a nationally driven program to a city level initiative. Further analysis using Governance, Policy, and Service framework would capture the key differences of providing longterm smarty city services either from top-down or bottom-up approaches. This research primarily adopted the key characteristics of megaprojects to smart city development. Future study investigating the smart city ecosystem and its economic impact on technological innovation and adaptation as well as the long-term sustainability strategy would provide better understanding of the challenges and opportunities of smart city.

6.3 The Future of Sustainable Smart Cities

As the economy matures, the standards of living become higher and the needs of citizens become more diverse and sophisticated. We are also living in a fast-changing world. The role of the smart city is to provide physical and cyber infrastructures that can provide various services. However, high-tech products have a very short lifespan these days. How can we solve the shorter lifespan of smart cities and keep up with the latest technological advances?

This will be one of the biggest challenges in creating the sustainable smart city of the future.

The sustainable smart city programs will serve as an important reference for the future of megaproject management. Just as ICT converges with a building and becomes a smart building, other megaprojects will emerge as smart megaprojects by their incorporation of ICT. In fact, we are living in a subscription economy using platforms. Software and ICT companies are moving from a one-time product sales model to a subscription-based business model. The shift to a subscription strategy will enable companies to continually provide services and generate revenue as well as monitor the value of their products and gain continuous feedback. Similarly, for smart cities, services such as the subscription economy with continuous customer feedback will require a new smart city ecosystem in which new services can be created, tested, and fine-tuned according to the needs of citizens.

Many predict that our culture and city will change significantly after the coronavirus disease 2019 (COVID-19) pandemic. In South Korea, the strict governmental control of the COVID-19 pandemic through contact tracing using smartphones raised concerns regarding violations of privacy protections as the contact tracing of COVID-19 patients could possibly and inadvertently reveal private information. Although contact tracing is intended to inform the citizens of a COVID-19 patient's travel route, there is also a great concern that the current system reveals too much information and, as a result, has unintended consequences, such as the closure of businesses. These issues raise questions regarding how to strike a balance between public health and privacy. The recent shutdown of the Google Sidewalk project

in Toronto, Canada raised a similar issue—that companies were pirating personal privacy to generate profits [82].

The national pilot smart city in Korea plans to establish a Special Purpose Company (SPC) jointly funded by the public and private sectors in 2021. The SPC will enable the private sector to participate from the outset of the planning phase through the operation phase. The governance structure will be established wherein the private sector participates to utilize ownership and capital power for continuous operation without being shaken by changes in external conditions. The SPC model in which a clear governance structure is in place will be key to the successful implementation of a long-term, sustainable smart city. Recently, South Korea established the Smart City Master Planner Act, wherein a master planner serves as a control tower of a smart city program. However, the government decided to reduce the master planner's authority. There must be a clear and explicit role for the master planner and SPC governance board to minimize any unnecessary conflict or power struggles.

In addition to Korea, other countries have recently established SPCs or joint institutions to coordinate and manage smart city programs. Korea's long history of smart city programs and its continuously improving smart city initiatives and proposed sustainable smart city framework can serve as best practices for other countries trying to develop smart cities in the future. The shift in the center of attention from technology adoption to GPS will make a difference to the long-term viability and success of smart city programs.

The smart city will have challenges that require harmony between di-

verse stakeholders. Smart cities will need to create an open innovation structure to solve such problems. Governance structures are required for arbitration, negotiation, and mitigation to address and solve problems involving various stakeholders. Governance should ensure unity between the institutional, legal, and sustainable operation of the various organizations.

초록

스마트시티 프로젝트를 위한 거버넌스, 정책, 서비스 (GPS) 프레임워크 개발 사례연구: 한국 스마트시티 프로그램을 중심으로

이재현
응용공학과 응용공학전공
서울대학교 공학전문대학원

한국은 기술의 진보로 새롭게 출현한 서비스를 도시 물리 인프라에 융합시켜오고 있으며, 지속가능한 도시 건설을 위해 오랜기간동안 스마트시티 개발 프로그램을 추진해오고 있다. 그러나 아직까지 스마트시티의 성공모델을 제시하기에는 성과가 부족한 실정이다.

본 연구는 스마트시티 건설의 주요 요소를 파악하기 위해 다음의 연구질문으로 연구를 시작한다. 기술적용과 구현을 넘어 성공적이고 지속가능한 스마트시티 건설을 위한 주요 특성은 무엇인가? 연구질문을 정의하기 위해 한국 스마트시티 프로그램에 대한 포괄적인 검토 및 질적연구를 수행하였으며, 확인한 주요특성을 반영하여 프레임워크를 제시하였다. 프레임워크를 설계하기 위해 첫째, 스마트시티와 메가프로젝트 관련문헌을 검토하였다. 저자의 과거 연구에서 스마트시티와 메가프로젝트에 유사한 특성이 있다는 것을 확인했으며 [1], 이 연구에서도 메가프로젝트관련 문헌조사를 활용하였다. 둘째, 한국의 오랜 스마트시티 프로그램 실행 과정

에서의 핵심 이슈를 파악하기 위해 관련기사를 수집하여 분석하였으며, 여기서 확인한 주요 요소를 다양한 소스의 데이터를 활용하여 검증하였다. 마지막으로 한국 스마트시티 프로그램의 사례를 종합적으로 분석하여 프레임워크를 개발하였다. 개발한 프레임 워크는 지속가능한 스마트시티 건설을 위해 정책 결정자, 기획자, 기타 주요 이해 관계자가 활용할 수 있다.

연구질문에 대한 결과는 다음과 같다. 첫째, 다양한 기술과 정보를 통합관리하기 위해서 마스터플래너와 프로젝트 거버넌스위원회를 운영해야 한다. 둘째, 규제 혁신은 스마트시티에 혁신적인 서비스를 제공할 수 있게 한다. 셋째, 지속가능한 스마트시티 서비스를 위해서 일괄된 서비스를 제공하는 것보다 도시와 시민의 요구를 반영하고 수익을 창출할 수 있는 서비스를 제공하는 것이 중요하다. 이 연구결과에 대한 대안으로 물리적 인프라와 신기술의 디지털 인프라를 통합하는 것 외에도 성공적인 스마트 시티 건설을 위한 프레임 워크의 세 가지 요소로 거버넌스, 정책, 서비스(GPS)를 제안했으며, 이를 통해 스마트 시티가 시민과 사회를 위한 새로운 서비스를 제공하는 인큐베이팅 플랫폼으서 기능해야 한다고 도출하였다. 본 연구가 지속가능하면서도 혁신적인 스마트시티 건설의 거시적 관점과 이해에 기여할 것으로 기대한다.

주요어: 스마트시티, 사례연구, 프레임워크, 거버넌스, 정책, 서비스, 한국
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