Global Smart City Solutions Catalog 2024

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Contents

CHAPTER 4 — Cases for Sectoral Smart Services

Contents | **Tables, Figures, Boxes**

Tables

Figures

Boxes

Abbreviations

AI	Artificial Intelligence
AMI	Advanced Metering Infrastructure
API	Application Programming Interface
AUAS	Amsterdam University of Applied Science
BAS	Building Automation Systems
BIS	Bus Information System
BMZ	GmbH with the German Federal Ministry for Economic Cooperation and Development
CCTV	Closed Circuit Television
CIS	Combined Information System
DMS	Distribution Management Systems
ECS	Energy Control System
EOC	Energy Operation Center
EU	European Union
ERAV	Electricity Regulatory Authority of Vietnam
GOES	Geostationary Operational Environmental Satellite
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPS	Global Positioning System
GPURL	Global Practice for Urban, Disaster Risk Management, Resilience, and Land
GSCP	Global Smart City Partnership Program
GUI	Graphic User Interface
HAN	Hogeschool van Arnhem en Jijimegen
ICT	Information Communications Technology
IDEAM	National Meteorological Institute of Colombia
IT	Information Technology
ITS	Intelligent Transport Systems
ITU	International Telecommunication Union
IFEZA	Incheon Free Economic Zone Authority
JCCI	Jeju Center for Creative Economy and Innovation
JTO	Jeju Tourism Organization
KAIA	Korea Agency for Infrastructure Technology Advancement
KCC	Kumkang Korea Chemicals Corporations
KPI	Key Performance Indicator
KT	Korea Telecom
LiDAR	Light Detection and Ranging
LOSI	Local Online Services Index
MaaS	Mobility as a Service
MACCA	Multifunctional Administrative Construction City Agency
MOIT	Ministry of Industry and Trade
MOLIT	Ministry of Land, Infrastructure, and Transport
NGO	Non-governmental Organization
NOAA	National Oceanic and Atmospheric Administration
ODC	Open Data Committee
PPAs	Power Purchase Agreements
PPP	Public–Private Partnership
QR	Quick Response
R&D	Research and Development
RTA	Roads and Transport Authority
SATC	Sistemas de Alerta Temprana Comunitarios
SATI	Sistemas de Alerta Temprana Inclusivos ante Inundaciones
SCADA	Supervisory Control and Data Acquisition
SGREEE	Smart Grids for Renewable Energy and Energy Efficiency
SIATA	Sistema de Alerta Temprana del valle de Aburrá
SMG	Seoul Metropolitan Government
SMS	Short Message Service
TOPIS	Transport Operation and Information Service
STEM	Science, Technology, Engineering, and Mathematics
UGRM	Flood Risk Management Unit
UN	United Nations
ZEB	Zero-Energy Building
ZEH	Zero Energy Housing

CHAPTER 1

Introduction

1.1. Background

Currently, more than 4.5 billion people reside in cities worldwide, accounting for over half the world's population[1]. This number is projected to reach 6 billion by 2045. Cities, as agglomerations of talent, knowledge, and resources, serve as engines of national economic growth. However, unless effectively managed, rapid urbanization generates multidimensional challenges such as urban sprawl, overcrowding and congestion, crime and violence, and unplanned development. Moreover, given their population density, cities contribute to and are vulnerable to global crises, including climate change, pandemics, and conflicts.

In the era of digital transformation, several cities have used smart solutions and services to address urban challenges and improve their citizens' quality of life. The concept of smart cities, in which cities utilize data and digital technologies to improve urban planning, management, service delivery, and citizen engagement, has emerged in this context[2]. With the global penetration of digital technologies in every aspect of urban living—from low-tech to cutting-edge disruptive solutions—there is an increasing interest in smart cities as a vision, planning approach, and package of solutions to fulfill citizens' aspirations.

Developing countries share a similar degree of interest and ambition to address pressing challenges (e.g., safety issues, inadequate housing and infrastructure, vulnerability to disasters, and environmental degradation) using data and digital technologies. Acknowledging the importance of the smart city agenda in building resilient, sustainable, and inclusive cities, the World Bank launched the Global Smart City Program (GSCP)[3] in 2018. The program was funded by the South Korean government and implemented by the World Bank's Global Practice for Urban, Disaster Risk Management, Resilience and Land (GPURL).

The GSCP aims to support World Bank Group teams and their client countries in developing good smart city practices and solutions and enhance their capacity for planning and implementing smart city investment projects. For the past five years (that is, from 2018 to 2023), GSCP has supported over 50 smart city engagements, in which benchmarking has stood out as an effective tool for stimulating interests, formulating visions, and designing smart interventions.

1 https://data.worldbank.org/indicator/SP.URB.TOTL
2 World Bank. 2023. *Global Smart City Partnership Program PHASE 2 COMPLETION REPORT.* Washington, D.C.: World Bank.
3 https://www.worldbank.org/en/programs/global-smart-city-partnership-program

This catalog was developed to collate smart city benchmark cases that GSCP experts have used during the implementation of GSCP support. Furthermore, the catalog introduces other good practice benchmarks from diverse countries and city contexts to serve as a more comprehensive repository for ongoing and future engagements of the GSCP as well as cities and experts interested in the agenda.

1.2. Objective and Structure

The objective of the catalog is to provide good practices to those interested in understanding the process of smart city development and adopting relevant strategies and solutions. The catalog aims to be a practical guide for planning effective smart city implementation and presents selected good approaches and use cases with achievements and challenges.

Specifically, the catalog targets the key actors involved in the planning, implementation, management, monitoring, evaluation, and utilization of smart city services who include, but are not limited to, central and local government officials, city leaders and decision-makers, urban planners and engineers, private sector partners, academics, civil society organizations, and citizens. Using the good practices of smart city strategic planning and implementation, the catalog intends to help policymakers and practitioners adapt successful models to their own contexts. The catalog also aims to inspire innovation by showcasing smart city services that use cutting-edge technologies.

The catalog is organized as follows. Chapter 2 discusses the concept of smart cities and their four building blocks: vision and strategy, institutions, technology, and finance. Chapter 3 demonstrates the overarching process and foundation of smart city development across various sectors using relevant reference cases. Specifically, it underlines the importance of developing a strategic smart city vision and planning upstream to coordinate downstream cross-sectoral implementation through examples of smart city strategic planning in South Korea and Singapore. Finally, using other cases, it illustrates how the three building blocks (institutions, technology, and finance) also play a vital role.

Chapter 4 provides a range of smart services organized by theme and sector and implemented in various countries. Each case covers the challenges, benefits, and replicability of these services. The cases present practical information specific to project implementation and key takeaways, allowing readers to refer to them when planning or designing smart city projects and strategies.

CHAPTER 2

Conceptual Framework of the Smart City Catalog

2.1. Phases of Smart City Development

The idea of smart cities as cities that use information and communication technologies (ICT) to solve urban challenges and improve urban living emerged in the mid-to-late 2000s. While commonly used, "Smart City" has no universally agreed upon definition. To date, many international organizations have presented the concept of a smart city. However, the definitions by the United Nations (UN) and International Telecommunication Union (ITU) comprehensively capture the common elements of the various definitions.

- UN: A smart city makes use of opportunities from digitalization, clean energy, and technologies, as well as innovative transport technologies, thus providing options for inhabitants to make more environmentally friendly choices and boost sustainable economic growth and enabling cities to improve their service delivery[4].

- ITU: A smart sustainable city is an innovative city that uses ICT and other means to improve the quality of life, efficiency of urban operations and services, and competitiveness while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental, and cultural aspects[5].

Representing a city's vision of innovation, smart city development is a long-term, multi-sectoral process that undergoes phases of digitization, digitalization, and digital transformation, representing the varied maturities of service automation and social transformation[6].

Digitization. The most fundamental step for developing a smart city is "digitization," a process of changing our physical and living environment from an analog to digital form. An exemplary digitization project involves the conversion of paper-based administrative documents into electronic files. Another example is the conversion of all public transportation payments from cash to smart transportation cards, which digitize all transactions. Installing the Internet of Things (IoT) in street waste bins to detect the filling status and operate waste collection vehicles digitally based on this data is also a good example of digitization. Digital infrastructures, such as various types of sensors and fiber optic networks, collect and

4 United Nations. 2017. *New Urban Agenda.* https://habitat3.org/wp-content/uploads/NUA-English.pdf
5 ITU-T Y.4900
6 Betsy Reinitz. 2020. *Consider the Three Ds When Talking about Digital Transformation.* https://er.educause.edu/blogs/2020/6/consider-thethree-ds-when-talking-about-digital-transformation

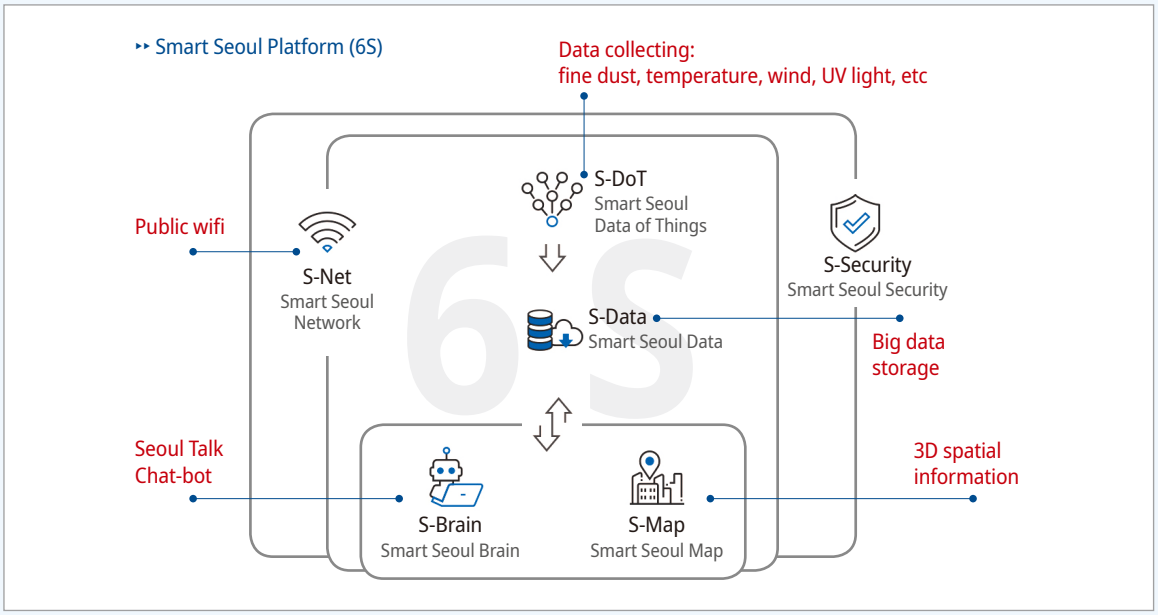
transmit metadata to a smart city information center that enables cities to monitor analogous physical city environments in real time. Without digitization, it is almost impossible to optimize and automate smart city services.

Box 1. Digital Infrastructure of Seoul

Seoul, a cutting-edge smart city, has been well equipped with a digital infrastructure called 6S for over 30 years. Figure 1 indicates Seoul's six core digital infrastructure for smart city development. First, the Smart Seoul Network (S-Net) has over 4,000 km of fiber optical communication networks throughout the city and public Wi-Fi and IoT network facilities in the critical corners of the city. Second, S-DoT (Smart Seoul Data of Things) produces various image and detection data through smart poles with approximately 20,000 Wi-Fi devices. The IoT technology is jointly operated and managed by the private sector to monitor the city status in real time. Third, Smart Seoul Data (S-Data) is built into 518 types of city administration information systems and big data application systems with data standardization and quality management. Fourth, S-Brain (Smart Seoul Brain) is an artificial intelligence (AI)-based service platform that provides customized services to citizens. Fifth, S-Map (Smart Seoul Map) utilizes digital twin technology to provide smart city services through a three-dimensional (3D) spatial information platform. Finally, S-Security (Smart Seoul Security) operates intelligent Closed Circuit Television (CCTV) to ensure and monitor citizens' safety.

The 6S digital infrastructure is well equipped with cybersecurity measures to protect personal information and prevent cyberattacks. Notably, the success of a smart city project depends on the accuracy and usefulness of the information provided, which must be secured and trusted. In this context, self-owned fiber optic networks are critical to ensure digital infrastructure's security and cost-effectiveness.[7]

Figure 1. Seoul's 6-S Digital Infrastructure



Source: Smart Seoul Website (https://smart.seoul.go.kr/)

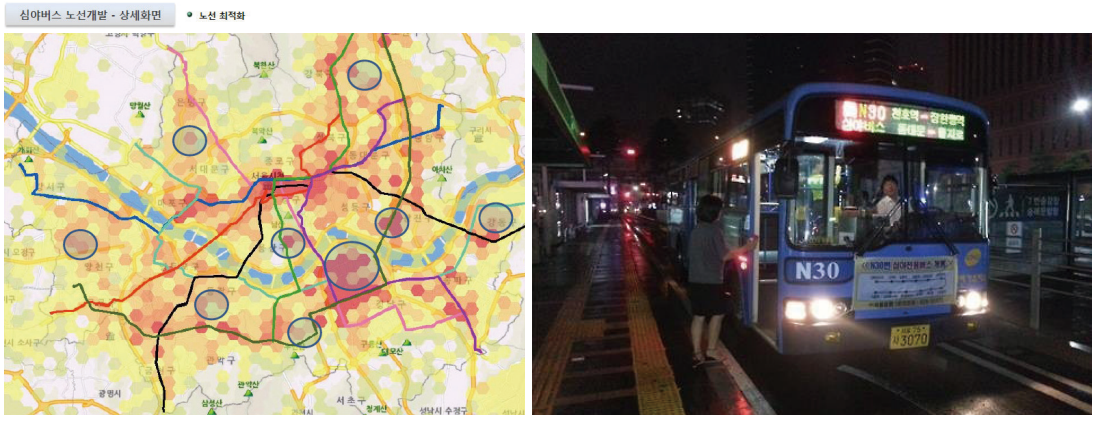
7 Seoul Smart City, 2020. *Changing the Lives of the Citizens.* Seoul Metropolitan Gov.

Digitalization. The second phase is "digitalization," which turns digital data into useful information distributed via an information platform through digital technologies, including big data and AI. The digitalization process of collecting and processing data on traffic volume, density, and speed through intelligent transport systems (ITS) has been implemented since the early 90s to address transport failures. A digital transport management system can monitor the traffic situation of an entire city and provide the shortest route information to drivers in real time. Moreover, with an origin and destination (OD) matrix that analyzes transportation transaction data, citizens' travel patterns can be identified and utilized in urban transportation planning and operations. In terms of crime prevention, intelligent CCTV provides an autonomic warning system for citizen safety when a crime occurs based on movement tracking and AI technologies. Recently, cutting-edge technologies, such as metaverse[8] and digital twins[9], have been used to simulate traffic flow and analyze climate impacts by utilizing 3D geographic information systems.

Box 2. Smart Bus Service of Seoul

Digitalization refers to analyzing, processing, and converging digital data to provide customized and useful services. In this process, highly reliable information obtained through digitalization provides basic input for evidence-based planning, enabling effective urban facility operations and strategic mid- to long-term planning. A representative example of digitalization is Seoul's bus services. As shown in Figure 2, since 2013, Seoul has combined 3 billion big mobile datasets and 5 million taxi operation datasets to optimize late-night bus routes. The core of the service lies in providing user-tailored interactive services rather than simply providing generic information. Based on bus user data and requests, Seoul can provide night bus services to carry more passengers and reduce the overall bus operating costs.

Figure 2. Night Bus Route of Seoul



Source: https://seoulsolution.kr/en/content/night-bus-called-owl-bus-route-design-using-big-data

8 Metaverse is a compound word of 'meta', meaning virtual, and 'verse', meaning world. As seen from its derivation, the word metaverse means "a virtual world where humans, as avatars, interact in a 3D space that mimics reality". (Source: Cambridge Dictionary, https://dictionary.cambridge.org/dictionary/english/metaverse)

9 IBM defines a digital twin as "a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making." (Source: IBM website, https://www.ibm.com/topics/what-is-a-digital-twin)

Digital transformation. The final phase is "digital transformation," whereby synergies are created by integrating and upgrading digitalization in each sector, and interactions among government, businesses, and citizens are enhanced through interconnected digital services. For example, as citizens receive efficient route guidance through smartphone navigation services and adjust their travel patterns, the overall flow of the transport network is optimized. By introducing smart public transport cards, people are liberated from carrying cash or getting multiple tickets for different transportation means, making public transportation more accessible. The effective use of CCTV can help reduce illegal waste dumping or parking, making cities livable and clean.

Digital transformation can also contribute to cities' green growth with two strategic approaches. The first strategy is the green transformation of the entire cycle of Information Technology (IT) products and services based on green data centers and broadcasting and communications network infrastructure. These green infrastructures reduce energy consumption using eco-friendly hydrothermal or other renewable energy. They can also use energy optimization systems within operations to prevent energy waste. To ensure the long-term effect of the infrastructure, the government should provide standards and guidelines for technical construction and maintenance.

The second strategy is utilizing IT to maximize energy efficiency and accelerate the transition to a low carbon society. For example, governments can build network base stations to install public Internet of Things (IoT) sensors for climate data monitoring and collection[10]. Another example is digital twin technology, which can monitor critical infrastructure in real time, such as water dams. This intelligent technology can identify and solve problems before they occur, allowing operators to control the physical infrastructure in a virtual space, regardless of the distance.

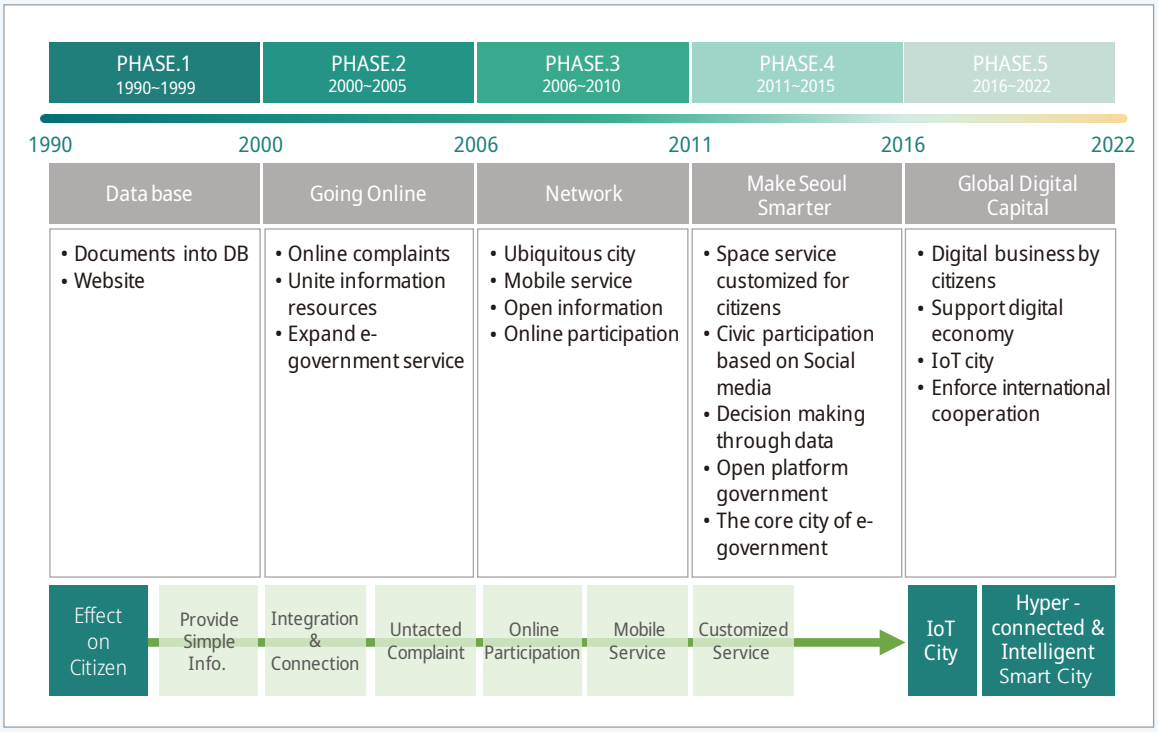
Digital transformation, however, naturally comes with risks associated with digitalized service systems interconnected across sectors, and vulnerability to cyber-attack poses great threats to the integrity of smart city development. Hence, the digital transformation of smart cities can be successfully achieved when backed by a robust system of safeguarding cybersecurity and privacy and enacting strict personal information protection and data industry promotion laws.

10 https://thedocs.worldbank.org/en/doc/08165a76ca0f1ef688d2782dfaab3406-0400072022/related/Greening-Digital-in-Korea-Korea-Case-Study-for-Greening-the-ICT-Sector.pdf

Box 3. Multi-decade, Multi-sectoral Smart City Journey of Seoul

Seoul, the capital city of the Republic of Korea, is a renowned smart city. Seoul was categorized as belonging to the very high Local Online Services Index (LOSI) group at the UN E-government survey 2022, marking 0.7674 points out of 1[11]. The city also claimed second place in the global smart city rankings operated by Juniper Research, a research institution in the United Kingdom. Seoul began its smart city-related projects in the early 1990s by promoting e-government, which supported office automation and the computerization of administrative tasks, as shown in Figure 3. After going through a 10-year digitization process that transformed the existing analog physical city into a digital one, starting in the 2000s, the Seoul Information Master Plan was established, and an information integration infrastructure was established by developing e-Seoul Net and opening a data center. Additionally, in 2006, a mobile wireless environment was established to lay the foundation for two-way communication with citizens and a control center for cyber security was established. The full-fledged smart city project began in 2011, when the 'Smart Seoul 2015' project was promoted, expanding public wireless Internet, promoting the use of mobile spatial information, and conducting smart information education for underrepresented groups. Since then, projects such as 'Digital 2020' and 'Smart Seoul 2025' have been promoted to implement innovative smart city services across municipal administrations, including transportation, welfare, culture, safety, environment, and tourism.

Figure 3. Smart Seoul Procedure



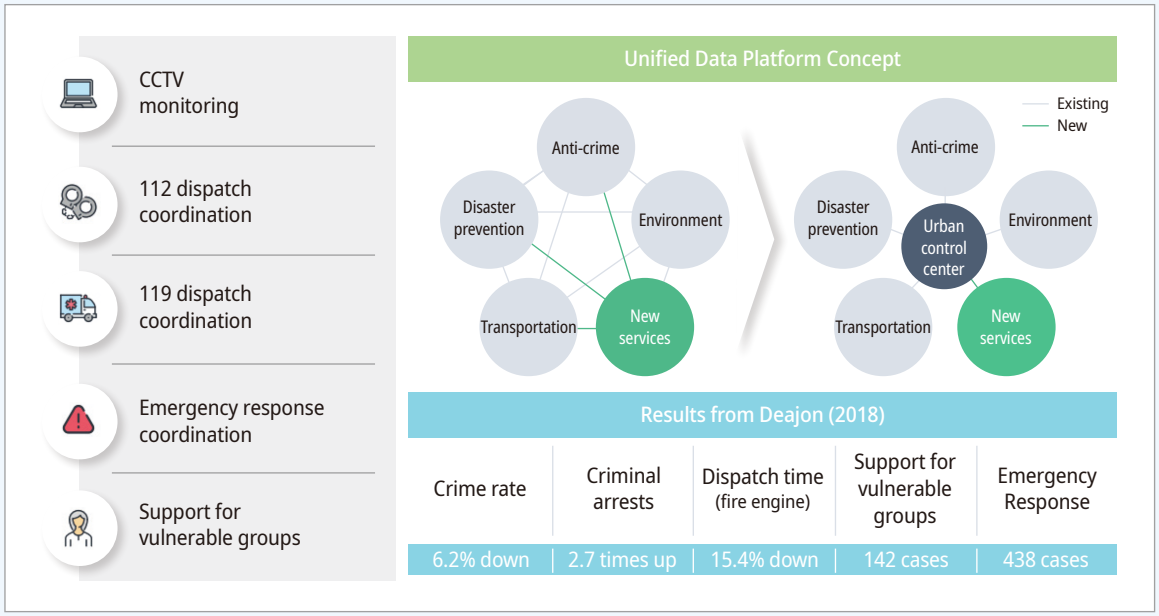
Source: created by the author referring to the Seoul Metropolitan Government (SMG). 2020. Seoul Smart City, Changing the Lives of Citizens. Seoul: SMG.

11 United Nations. 2022. *E-Government Survey 2022: The Future of Digital Government. New York:* United Nations.

Box 4. Integrated Information Platform for Digital Transformation in Korea

The main feature of digital transformation is that digital technology has made citizens' lives more convenient and safer. For this, it is important to develop an integrated information platform by integrating sector-specific information systems that were previously built in silos. Smart city facilities, including various CCTV and detectors that have been built and operated separately by each institution, can be jointly managed to share information and optimize maintenance costs. Furthermore, it allows a joint response among relevant agencies when an incident, such as crime, occurs. Mutual cooperation is also possible through an integrated information platform that ensures interoperability, even when administrative districts change (Figure 4). Ministry of Land, Infrastructure, and Transport (MOLIT) began developing the "Smart City Integration Platform" in 2015 and completed its distribution through matching funds to 229 local governments promoting smart city projects. As a result, for example, Daejeon reduced the response time of fire trucks by 15%, decreased the crime rate by 6.2%, and increased the criminal arrest rate by 2.7 times[12].

Figure 4. Concept of an Integrated Information Platform for Digital Transformation



Source: Ministry of Land, Infrastructure, and Transport (MOLIT), Korea

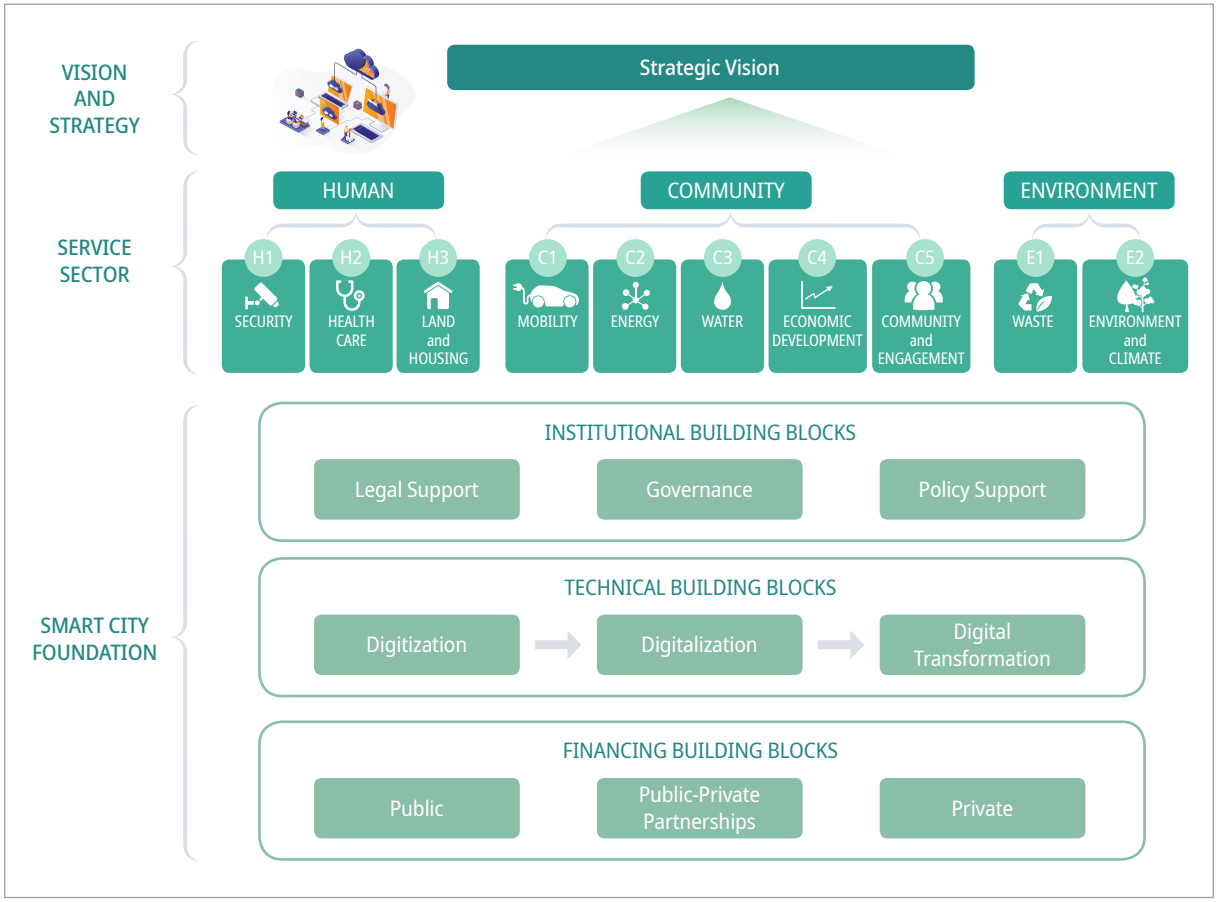
2.2. Smart City Conceptual Framework

The catalog provides a smart city conceptual framework comprising four major building blocks: vision and strategy, institutions, technology, and finance (Figure 5), which are cross-sectoral prerequisites for the successful development of smart cities. Above all, a strategic vision based on the current status of the city should be established through close collaboration with various stakeholders, who work together to achieve a common goal. It is also highly recommended to establish a more granular mid- to long-term action plan to realize the smart city vision in a stepwise manner.

12 https://smartcity.go.kr/en/%ed%94%84%eb%a1%9c%ec%a0%9d%ed%8a%b8/%ec%8a%a4%eb%a7%88%ed%8a%b8%eb%8f%84%ec%8b%9c-%ed%86%b5%ed%95%a9%ed%94%8c%eb%9e%ab%ed%8f%bc/

The second building block enables institutional arrangements consisting of three key components. Legal support is essential to propel smart city projects with mid- to long-term visions for at least ten years. In South Korea, the Ubiquitous City Construction Act, the world's first dedicated law for smart city development, was enacted in 2008 and has remained effective[13]. Furthermore, because smart cities cover a broad spectrum of services, it is important to establish good governance, such as inter-ministerial cooperation, and build effective public–private partnerships. Good examples include the 'National Smart City Promotion Committee' of the Korean government and 'Smart City Department' of the local government, which have played critical roles in consensus-building forums among various stakeholders. The third component is policy support, which includes national and local master plans, monitoring and evaluation, and smart city certification.

Figure 5. Smart City Conceptual Framework



Source: created by authors, 2023

The third building block is digital technology, which defines the level of development. Digital infrastructure is the most important component of digitization. Roadway furniture, including smart poles, public Wi-Fi, IoT, and cybersecurity are the core elements for gathering real-time status data. In the digitalization step, open information platforms, big data & AI, and city information systems are the major components. Additionally, data hosting services that ensure safe use and storing of data, stable

13 Enforcement Decree of The Act on The Promotion of Smart City Development and Industry: https://elaw.klri.re.kr/kor_service/main.do

connections, and accessible platforms are critical for the long-term capacity of data infrastructure. The final step is digital transformation, which is essential to develop innovative services through smart city-integrated information platforms for sharing each silo DB. Moreover, creating regulatory sandboxes and an environment where users can conveniently and effectively receive smart city services through living labs and citizen digital education is important.

The fourth building block is finance, which focuses on the efficient allocation of limited national and local government budgets. For example, the Smart City Challenge program in the USA and South Korea promotes virtuous competition by soliciting smart city development proposals from local governments and providing matching funds to support selected proposals. Additionally, it is essential to foster national pilot projects, such as autonomous shuttle buses and hydrogen power plants, as test beds for cutting-edge technology and their applications. The development of a sustainable business model within the private sector is critical for the financial viability of smart city initiatives. In this context, substantial policies have been made to develop a smart city industrial ecosystem. These policies include easing technical regulations to allow for smart city solutions and opening up access to urban infrastructure and public sector data, thereby supporting the growth of urban tech companies.

CHAPTER 3

Cases for Smart City Building Blocks

Smart city building blocks must be prepared from a cross-sectoral perspective, led by the central government or smart city public authority, before the provision of full-fledged smart city services in each sector. Developing strategic plans for each country and city can guide this upstream process by laying the foundation for all stakeholders to work together consistently toward common goals. To ensure stable progress toward long-term smart city development, a robust legal framework and effective governance as a forum for collecting opinions from stakeholders and building consensus through mutual understanding and discussion must be in place. Other building blocks include performance monitoring and evaluation, investment in digital infrastructure, and financing. This chapter explores benchmark cases of these cross-sectoral building blocks from leading smart countries such as South Korea, Singapore, Israel, and Austria.

3.1. Strategic Vision

3.1.1. National smart city vision of Korea

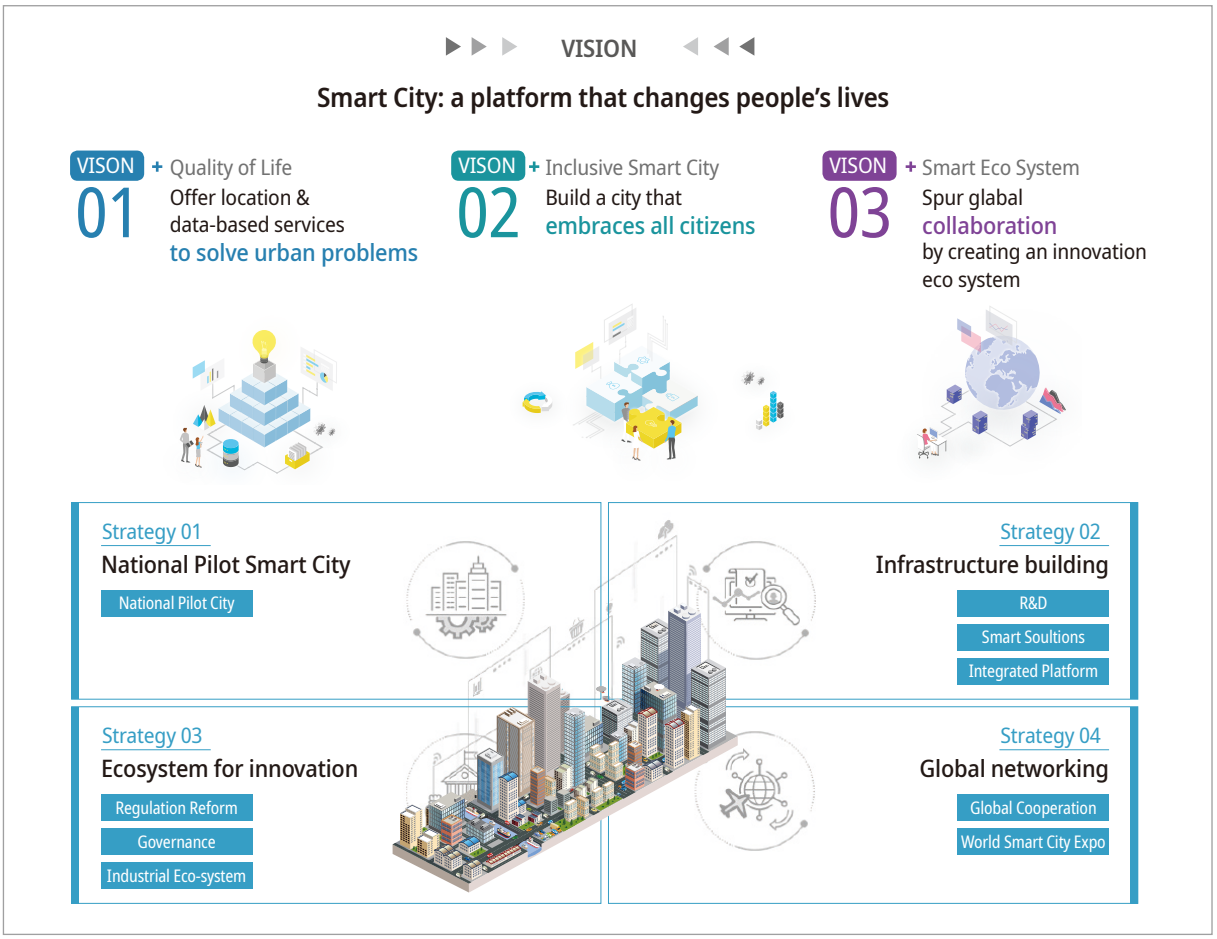
Over the past decade, Korea has developed smart cities led by the central government; notably, MOLIT has a vision to systematically and effectively solve urban issues, such as traffic congestion, environmental pollution, and crime, which have arisen during the rapid urbanization over the past 60 years, coupled with a long-term vision of utilizing cutting-edge information and communication technologies for city planning and management. Korea's smart city vision is supported by four implementation strategies, thus increasing the possibility of its realization (Figure 6).

First, pilot projects were launched: Sejong and Busan were designated as national pilot project cities and test beds for cutting-edge smart city technologies. Second, feasible solutions and integrated platforms suitable for new and old cities were developed through smart city research and development (R&D) and the Challenge Projects, which provide matching funds for the promotion of local government's participation. Third, innovative services were implemented through a regulatory sandbox that provided a creative testbed without regulations or restrictions, built an industrial ecosystem, and formed cooperative governance among the public, private, and academic sectors. Finally, the World Smart City Expo and K-City Network Initiatives[14] are hosted by MOLIT annually to promote smart city experiences

14 The Ministry of Land, Infrastructure, and Transport is promoting the K-City Network global cooperation program to discover intergovernmental (G2G) smart city cooperation projects and to support global smart city projects.
Link: https://smartcity.go.kr/en/%EA%B8%80%EB%A1%9C%EB%B2%8C-%EC%8A%A4%EB%A7%88%ED%8A%B8%EB%8F%84%EC%8B%9C/k-city-network/

and share Korean smart city development experiences with worldwide partners. These initiatives are expected to build and strengthen global cooperation in Smart City development.

Figure 6. Smart City Vision of Korea

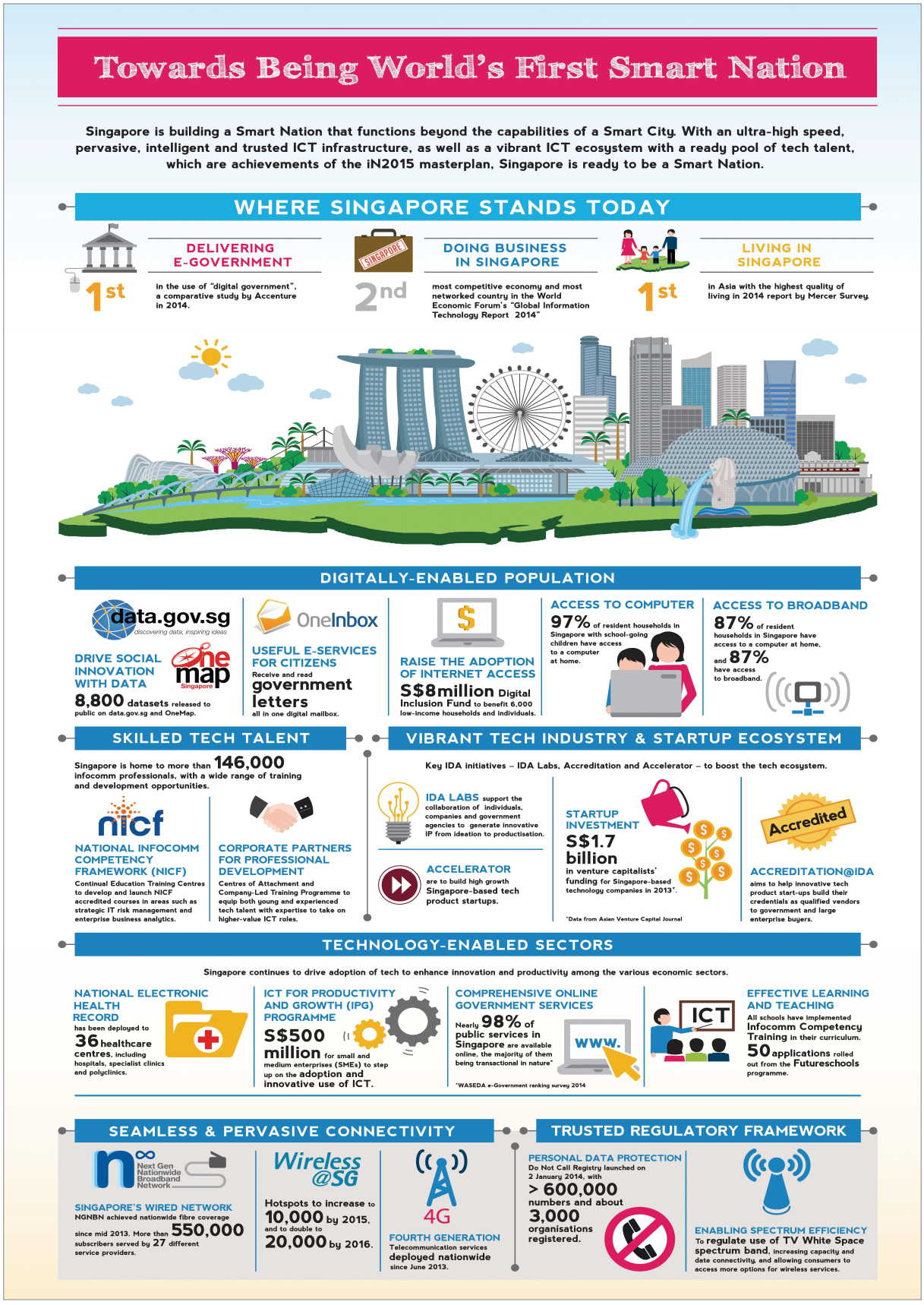


Source: Smart city Korea website, https://smartcity.go.kr/en/

3.1.2. Singapore's Smart Nation Vision

Singapore is known as one of the most advanced smart cities worldwide. Its renowned smart nation program was established in 2014, and the smart city project has been promoted systematically with the vision, 'Towards Being World's First Smart Nation' shown in Figure 7. In particular, it focuses on supporting the aging population, addressing urban density, and maintaining sustainable energy development and actively attracts investments from the global private sector by acting as a living lab. The main service areas suggested in the program are healthcare, integrated public services, urban planning, urban transportation and safety, and quality of life improvement. Singapore established a concrete national smart city vision, presenting quantitative indicators and target years for each area such as the digital population, industrial ecosystem, service sector, and digital infrastructure. More specifically, Singapore can be regarded as the most advanced smart country, with a computer usage rate of 97% and a broadband usage rate of 87%, investing S$1.7 billion in fostering startups and providing 98% of public administration services online.

Figure 7. Building Blocks of Smart Nation Vision



Source: Towards Being the World's First Smartest Nation, Infocomm Development Authority of Singapore

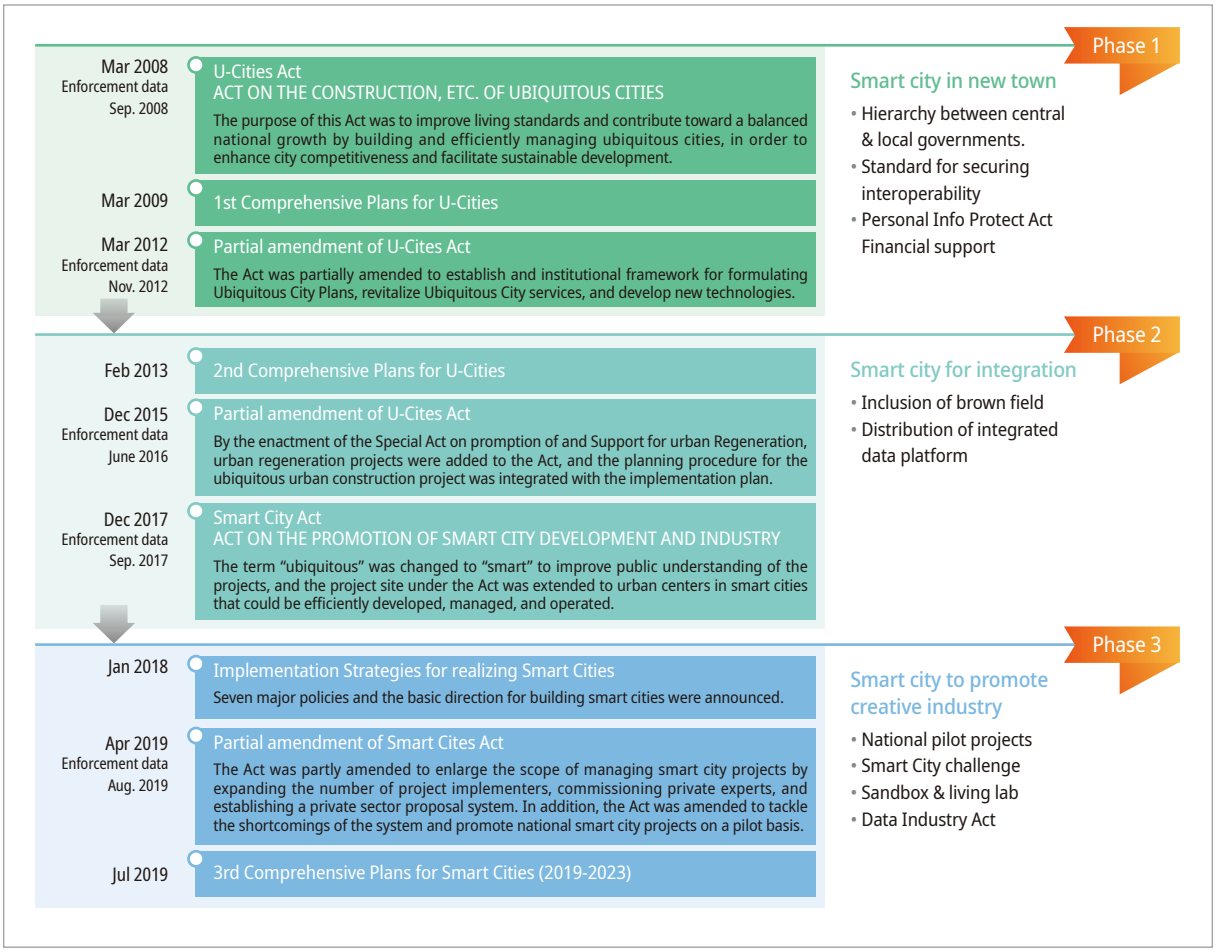
3.2. Institutional Building Blocks

3.2.1. Legal support

Among the various institutional building blocks, the primary objective is to establish a robust legal foundation that ensures the stability, consistency, and basic framework of smart city project implementation based on the consensus among stakeholders. For example, in 2008, South Korea enacted the world's first "Special Act on Smart City Development Promotion," which secured legal status for smart city master plans, implementation organizations, and financial support. Subsequently, through two rounds of revision, a national smart city master plan was established every five years to promote systematic and consistent project implementation.

In Korea, smart city development is typically initiated with new-town development projects. As shown in Figure 8, Phase I (2008–2012) aimed to establish a legal basis for developing a smart city in a new city. The first national master plan for smart city development was developed during this period, including a standardization policy. The provision of this legal basis is significant because it laid the foundation for Korea to pursue smart city projects in a stable manner. It also suggests role assignments and financial investment plans for each stakeholder in the public and private sectors, thereby enhancing project implementation. In Phase II (2013–2017), Smart City projects were extended to existing urban areas and focused on a standardized integrated platform and distribution to local governments. In Phase III (2018-2023), full-scale project implementation by MOLIT was accelerated to industrialize smart city businesses by driving the National Pilot Project, the Challenge Project, the Living Lab, and the Sandbox with the enactment of the Data Industry Act. This legal support was critical to promote mid-to long-term national projects and provide a stable foundation. Additionally, this special law is expected to minimize conflicts between stakeholders that may occur during project implementation. Details of this law can be obtained from the website shown in Figure 8.

Figure 8. Legal and Planning Support for Smart City Development (2008~2023)



Source: Smart city Korea website, https://elaw.klri.re.kr/kor_service/lawView.do?lang=ENG&hseq=57433

3.2.2. Governance

Bottom-up Approach for Citizen Participation and Inclusion

Smart city services can enhance communication and inclusivity among citizens in public administration; to achieve this, governance that promotes citizen participation should be pursued. Vienna and Austria are good examples. Figure 9 below shows that the vision of Vienna to become "Smart Climate City" is based on forming a culture of democratic citizen participation in developing innovative ideas through living labs and expressing a wide range of opinions, coupled with the support of all social classes, including youth and children. Support for citizen participation is the first step to generating long-term human resources equipped with digital skills and knowledge. A participation hub and smart city workshop can help citizens to familiarize themselves with new technologies, share information, receive training, and educate each other through activities.

A specific example is The Neighborhood Oasis, which has existed since 2015[15]. The project aims to utilize public spaces by co-shaping its parklets, flower beds, or busking places with residents. This

15 https://smartcity.wien.gv.at/en/neighborhood-oasis/

smart city initiative aims to improve the quality of life with the district-level participation of citizens, organizations, schools, and companies through approximately 380 projects. Moreover, "Participation Hubs" were installed in all administrative departments within the city government to provide a systematic and standardized mechanism for collecting citizens' opinions. Additionally, to achieve net-zero emissions by 2040, Vienna established administrative procedures to improve transparency and citizen participation in public budget execution. Furthermore, to revitalize living lab activities at the district level, Vienna encourages community and forum activities with local non-governmental organization (NGO) involvement as the focal point and supports networking among stakeholders. A notable feature is that the city collates requests of young people actively by conducting 1,300 workshops through the "Werk Statt Wien" platform[16].

Figure 9. Vienna's Smart City Governance for Citizen Participation

Source: https://smartcity.wien.gv.at/wp-content/uploads/sites/3/2022/05/scwr_klima_2022_web-EN.pdf

Top-down Approach for Smart City Governance

Institutional capacities can make a significant difference in supporting the implementation and operation of smart city programs. Well-managed and systematic institutions serve as channels to effectively facilitate regulation and exchange information with various stakeholders at the different stages of smart city planning. In Korea, a "Smart City Special Committee" under the Presidential Office has been

16 https://www.werkstattwien.at/

formed to build top-down governance among government, industry, academia, and NGOs and discuss nationwide issues for smart city development. Moreover, each local government has begun to establish a "Smart City Unit" to integrate smart city relevant projects. In private sector governance, the "Smart City Association" was established in 2018 to promote the smart city industry and facilitate the exchange of technology, information, and academic research related to smart cities[17]. Its main activities include smart city data analysis, policy proposals for smart city development, international cooperation, the creation of a startup economy, smart city certification, and smart city business management. Through these programs, the association aims to expand the smart city network and improve the quality of urban life.

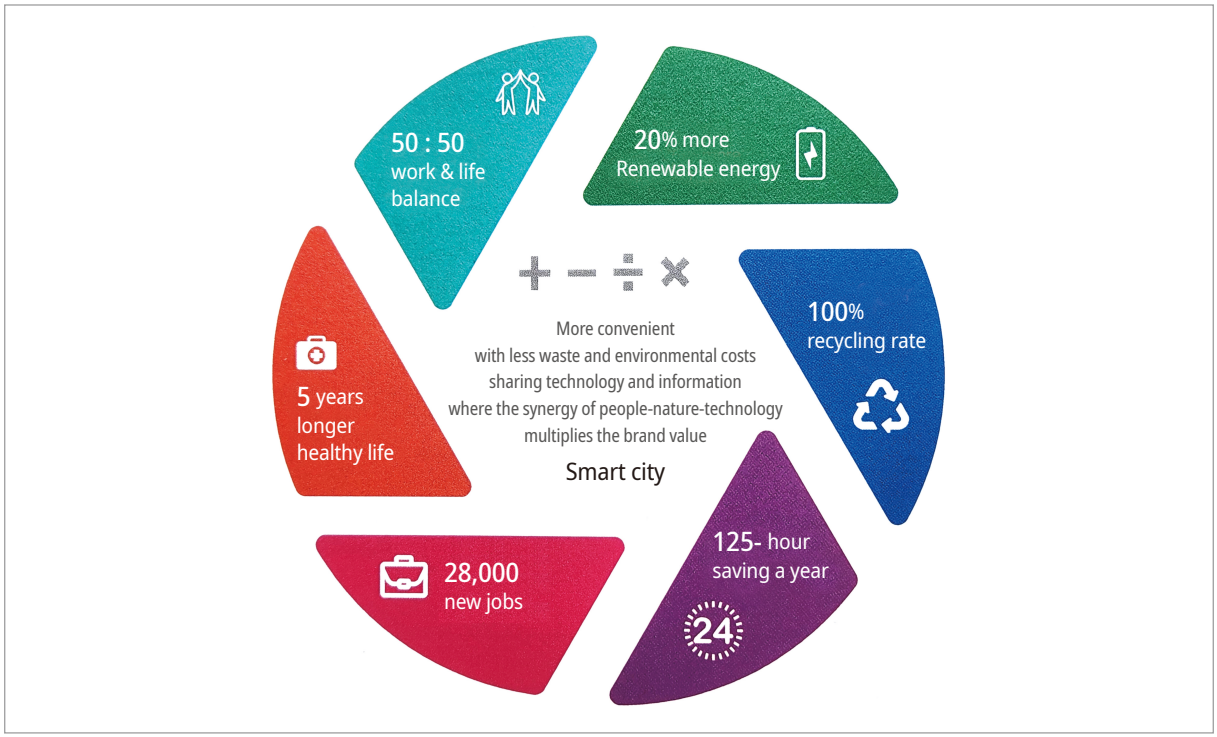
3.2.3. Policy support for compatibility and interoperability

The core of a smart city project lies in establishing urban information systems, which necessitates ensuring compatibility and interoperability among urban management systems through policy support from the central government. The central government should monitor the progress of smart city projects across all regions, analyzing the level of development to foster cohesive development and reduce any regional divides. Policy support for smart city projects can be provided in various forms such as monitoring, evaluation, certification, and standardization. These measures are crucial for assessing project goals and ensuring the sustainability of the system. Furthermore, the need for information-sharing among various interfaces to provide smart city services and data standardization for compatibility and interoperability cannot be overemphasized.

An example of a successful smart city project is the Eco Delta City construction project in Busan, which is being promoted as a national pilot project in South Korea. The evaluation of this project utilized six core key performance indexes (KPIs) and 28 relevant quantitative KPIs. These six core areas include healthcare, work-life balance, renewable energy utilization, resource recycling, congestion reduction, and job creation, as shown in Figure 10. To further enhance smart city initiatives, the Smart City Act was revised to implement a smart city certification system for performance management at the national level. This system has been in effect since 2021, following a pilot project. Smart city certifications have been granted to eight local governments by applying 63 evaluation indicators related to innovation, governance, institutions, services, and technical infrastructure[18]. Through this, Korea aims to establish its credibility and reputation as a smart city, both domestically and internationally, while also serving as a benchmark for other local governments. The implementation of smart city certification systems[19] can facilitate the dissemination of successful smart city service cases, minimize trial and error, and reduce blind spots and duplications by providing standardized guidelines.

17 http://wsce.smartcity.or.kr/eng/
18 https://www.smartcitycelc.krihs.re.kr/eng/local/present.php?ptype=view&code=present_eng&idx=606&category=
19 https://www.smartcitycelc.krihs.re.kr/eng/

Figure 10. Eco Delta Busan Smart City's Six Core



Source: Evidence-based KPIs, K-Water

From a long-term perspective, training and educating professional personnel and strengthening institutional capabilities need to be prioritized. Given that most smart city solutions require proper handling of cutting-edge information and communication technology, as well as effective maintenance and operations, policy support for securing smart city related human capital becomes critically important.

3.3. Financing Building Blocks

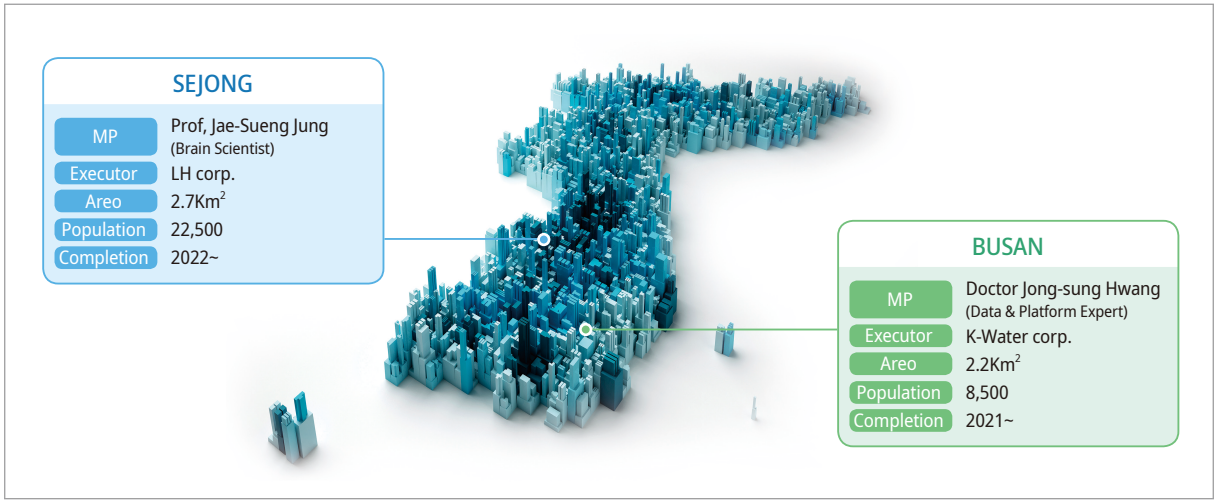
3.3.1. Public

Stable public sector investment is a significant factor in the successful implementation of smart city projects, which require large budgets and innovative technological development over a long period. Additionally, innovative service development is associated with risks. In this context, public funding holds immense importance as it supports the operation of test beds to incorporate cutting-edge technology, promote R&D projects, revitalize business promotion by matching funds with local governments, and ensure project consistency through integrated platforms and the standardization of project support.

Particularly, the public sector budget should actively invest in pioneering projects that adopt advanced technologies. A representative example is the National Pilot City Construction Project in South Korea. Since 2017, Korea has invested approximately USD 3.7 billion in promoting cutting-edge smart

city construction projects in the new urban areas of Sejong and Busan (Figure 11). The objective of this project was to build a future-oriented smart city on a pilot basis and apply cutting-edge technologies. Representative technologies include autonomous driving cars, drones, blockchains, digital twins, and hydrogen energy. Since 2020, the Sejong City Project has been actively promoted by developing seven innovative service areas: transportation, health, education, energy, governance, culture, and jobs. In particular, future-oriented transport services, such as shared transportation, which actively utilizes autonomous driving, personal mobility, and Mobility as a Service (MaaS), which utilizes AI and integrated information platforms, are actively piloted and adopted. The Busan Eco Delta City project pursues a 100% energy-self-sufficient city and implements ten innovative services. Led by the K-Water Public Corporation, this project successfully built an eco-friendly waterfront. Notably, the project emphasizes building a robot-friendly infrastructure. With active investment from the central government, this pilot project is expected to successfully demonstrate disruptive technologies for smart city development, improve the overall national smart city level, and contribute to the development of global smart cities.

Figure 11. Overview of the National Pilot Project in Sejong and Busan



Source: Ministry of Land, Infrastructure, and Transport (MOLIT), Korea

3.3.2. Private

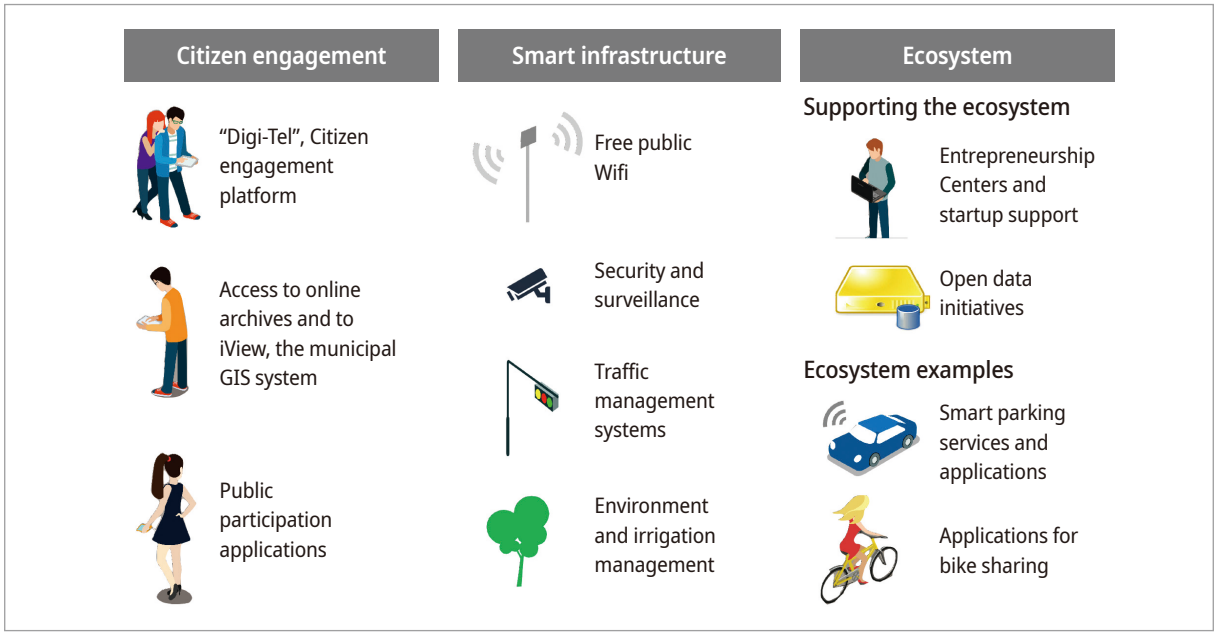
Leveraging the participation and investment of IT companies and startups is key to sustainable smart city development. However, developing a business model and engagement modality can be challenging as it involves trial and error and takes considerable time to succeed. Nevertheless, when implemented successfully, it can make substantial contributions to the innovation and sustainability of smart city systems.

Tel Aviv, with a population of 400,000, earned global recognition when it received the First Prize Smart City award at the 2014 Smart City World Congress[20]. While many cities have focused on publicly led top-down smart city projects, this city took a bottom-up approach to develop effective services

20 IDB. 2015. *International Case Studies of Smart cities; Tel Aviv, Israel,* Washington, D.C.: IDB

through the entrepreneurship of private companies and startups. Israel's business center is well equipped with an ecosystem of approximately 700 startups specializing in high-tech IT industries. Local governments provide substantial benefits, such as various tax benefits, workspaces, and special work visas, to promote startups. Moreover, public data accumulated by cities are effectively shared by smart service development companies. To promote collaboration with startups, the city has created formal procedures and facilitates direct consultations with experts for a strategic business model setup. The city also operates an online platform for such collaborations and has formed a special committee to explore ways to jointly provide more transparent and accessible collaboration. As a result, Tel Aviv successfully created a smart city ecosystem with core elements and functions (Figure 12).

Figure 12. Tel Aviv Smart City Ecosystem



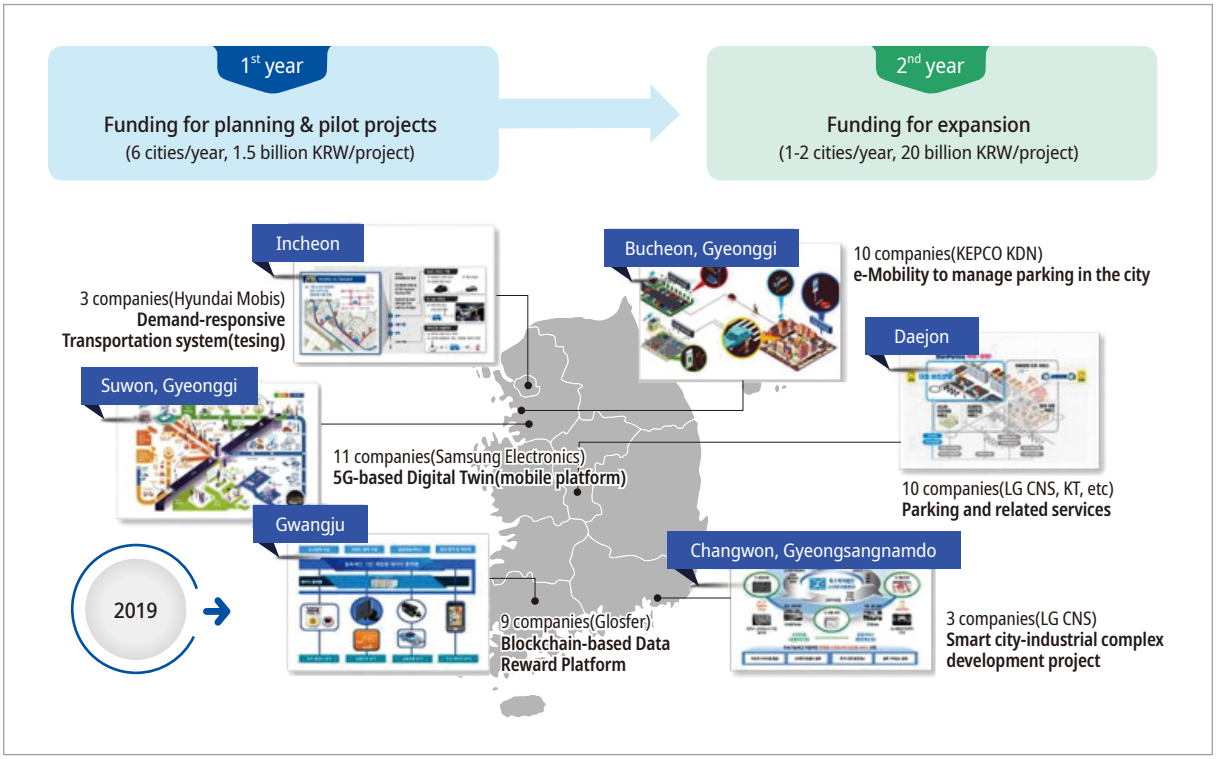
Source: IDB. 2015. International Case Studies of Smart cities; Tel: Aviv, Israel, Washington, D.C.: IDB

3.3.3. Public–Private Partnerships

The Smart City Challenge is a representative public–private partnership (PPP) initiative implemented by MOLIT, Korea. Since 2018, using the central government's matching fund for local governments, it has promoted the private sector's joint investment in developing locally customized smart city services. This statutory project is based on the Smart City Act and is promoted in three ways: city, town, and campus. The City Challenge focuses on solving problems across the city with ideas from private IT companies, while the Town Challenge focuses on specialized solution development for small- and medium-sized cities, with a particular emphasis on developing services in specific sectors. Finally, the Campus Challenge supports universities' innovative ideas by testing them within the region and linking them to commercialization.

To date, 14 local governments have been involved in preliminary or primary projects through fiercely competitive processes with the active participation of each local government, smart city service developers, academia, and research institutes. By the end of 2023, approximately USD 120 million in public–private partnership (PPP) funds had been invested, and various services, such as AI-based transport innovation services, autonomous driving and emergency medical services, eco-friendly mobility development, and demand-responsive transportation services, were being actively developed and built in beneficiary cities[21]. This program is a promising PPP project that aims to promote the service development capabilities of the private sector and local government leadership by providing matching funds from the central government (Figure 13).

Figure 13. Smart Challenge Projects as PPP in Smart City Development



Source: 2023 Smart City Brochure, MOLIT

21 https://smartcity.go.kr/en/%ed%94%84%eb%a1%9c%ec%a0%9d%ed%8a%b8/%ec%8a%a4%eb%a7%88%ed%8a%b8-%ec%b1%8c%eb%a6%b0%ec%a7%80/%ec%8a%a4%eb%a7%88%ed%8a%b8%ec%8b%9c%ed%8b%b0-%ec%b1%8c%eb%a6%b0%ec%a7%80/2021-%ec%98%88%eb%b9%84%ec%82%ac%ec%97%85/

CHAPTER 4

Cases for Sectoral Smart Services

This chapter introduces the downstream smart city services by sector: 1) safety, 2) land and housing, 3) mobility, 4) energy, 5) water, 6) smart tourism, 7) waste, 8) community empowerment, 9) public management and urban services, 10) health, and 11) climate change and environment. In these 11 sectors, the catalog introduces good smart city practices from various countries, offering readers practical knowledge about a pool of smart city services.

Each case progresses through a rationale for the issues a particular country or city faces within the relevant sector and the purpose of implementing the respective smart city service.

Each case primarily comprises an overview, basic information, key takeaways for each smart city service, and detailed information. The basic information section presents the background for each case, such as the countries and cities where the service was implemented, the scope of the service, the problems the service aimed to address, and the purpose and concept of the service. The key takeaways contain insights into the aspects that make the case a good practice. The detailed information encompasses more specific details, including the features of each solution, major actors involved, technologies utilized, estimated cost, and basic configurations. The 'Reference' under each case provides sources for specific information of the case, and the 'Further Information' section includes relevant information that is not directly cited in the case.

Table 1. The List of Smart City Good Practices

Sector	Case	Country
Safety	HarassMap	Egypt
	Ansimi App	Korea
Land and Housing	Toji-eum	Korea
Mobility	Transport Operation and Information Service (TOPIS)	Korea
Energy	Smart Grid	Korea
	Smart Grid	Vietnam
Water	Seoul Water Now System	Korea
Smart Tourism	Smart Island, Jeju	Korea
	Smart Dubai	Arab Emirates
Waste	Truck-free waste management system	Korea
Community Empowerment	Make IT Work Project	Netherlands
	iHub	Kenya
Public Management and Urban Services	mVoting	Korea
	Tokyo Digital Twin Project	Japan
Health	COVID-19 Response with ICT	Korea
Climate Change and Environment	Environmental Monitoring	Denmark
	SATI, early warning system for flood	Colombia
	Project SIATA	Colombia

4.1. Safety

4.1.1. HarassMap, Egypt

HarassMap is a volunteer-driven project of a non-profit organization in Egypt with a mission to foster an environment in Egypt that refuses to tolerate sexual harassment. To achieve this, HarassMap gathers short message service (SMS) and online reports detailing instances of sexual harassment and assault from victims or witnesses of sexual harassment. These incidents are then plotted on an online map as red dots, which serve as reference points for tracking occurrences, documenting positive interventions, and providing available support services. This map, along with associated reports on incidents of sexual harassment, sheds light on the prevalence and extent of sexual harassment issues, dispelling common misconceptions and excuses on sexual harassment.

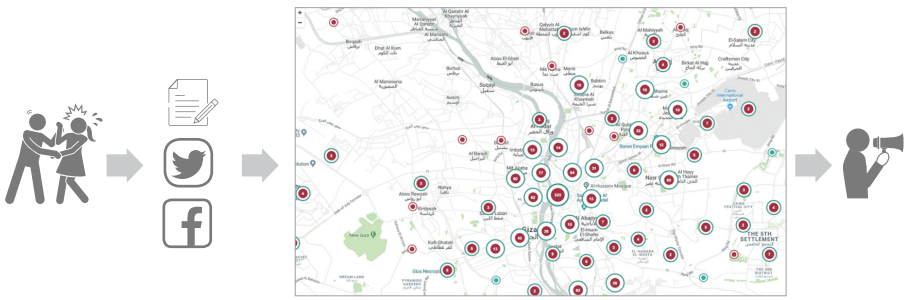
Dedicated HarassMap volunteers spread across Egypt leverage these reports to address sexual harassment issues within their neighborhoods. They engage with community members and urge them to confront those involved in misconduct. Volunteers also reach out to potential partners, such as shops, cafés, university campuses, and workplaces, and encourage them to adopt a zero-tolerance policy against sexual harassment within their premises. Challenging societal norms requires a critical mass of bystanders and community members to actively take a stance against such behavior. HarassMap not only utilizes such services in the national context of Egypt but also envisions a globally applicable sexual harassment tracking system in collaboration with its global partners, including the Sentinel Project, a Canadian non-profit organization that provides technological solutions for communities suffering from genocide.

City / Country	Egypt	Public ☐ Private ■ (Civil Society)	Service Scope	Nationwide

Sector	Safety	Project Launch	December 2010
Issues to tackle	Sexual Harassment		
Objective	• To help the population to oppose sexual harassment by restoring the social consequences of harassment and by creating role models who oppose it		
Concept	• A map application where anonymous reports of sexual harassment can be shared via computer or mobile phone		

Key Takeaways

- **Community-led initiative:** HarassMap demonstrates the effectiveness of community-led initiatives in addressing social issues, combining online participation with offline action. Engaging local volunteers and community members in the fight against sexual harassment creates a sense of ownership and empowers individuals to take actions within their own neighborhoods.
- **Utilization of visualization and mapping:** HarassMap's use of technology, such as SMS and online reporting platforms, combined with mapping tools, highlights the importance of data collection and visualization in understanding the scope and patterns of sexual harassment. This data-driven approach can inform targeted interventions and policy changes.

Feature	• Volunteer network: HarassMap is a volunteer-based initiative, and its core strength lies in its network of dedicated volunteers who contribute their time and effort to gather and map incidents of sexual harassment. • Online mapping platform: HarassMap uses an online map as a central tool to visualize and track incidents of sexual harassment. This mapping platform provides a user-friendly interface for reporting and viewing incidents, making it a key enabler of the organization's mission. • Community engagement: The organization's volunteers engage with community members to raise awareness about sexual harassment and encourage them to take actions against harassers. Building strong ties within communities is critical for the success of their grassroots activism. • Research and data analysis: HarassMap's efforts are supported by research and data analysis to assess social perceptions and responses to sexual harassment. This data-driven approach helps the organization tailor its interventions and strategies effectively.
Major Actors	• HarrassMap (Civil Society): HarrassMap itself is a non-profit organization which leads anti-sexual harassment initiatives while seeking institutional and community-based partners, mobilizing volunteers, and raising awareness of the issue. • Technical Partners: HarassMap works closely with the private sector actors, including technology corporate and academic institutions: - Ushahidi: Ushahidi is a global non-profit technology company. It provides HarrassMap with an online crowd mapping platform. - Uber: To scale up their effort nationwide, HarrassMap educated Uber drivers about sexual harassment and established a regional hotline for Uber users to report sexual harassment. - Cairo University: The faculties and staff of Cario University provides training for volunteers and contributes to implement anti-sexual harassment policies.
Utilized Technology	• SMS and online reporting / crowdsourcing / anonymous reporting and mapping interface
Basic Configuration	 Occurance of an Incident Reporting through SMS/SNS Mapping and Visualizing the Reported Incidents Feedback from the Community
Areas for Improvement	• The service only deals with the incident that has already taken place and has no direct connection to the police report.

Reference

https://harassmap.org/en/

https://views-voices.oxfam.org.uk/2016/11/making-invisible-voices-visible-in-online-evaw-campaigns/

https://city2city.network/harassmap-reporting-assault-innovation-type-community-organized

4.1.2. Ansimi App, Korea

The 'Ansimi'[22] App, developed by the Seoul Metropolitan Government, is a safety application designed to protect citizens from crimes. It provides passenger monitoring services using high-definition CCTV and smartphones. The app offers various safety services, including emergency reporting, safe return services for citizens, safe taxi services, and safe scout services. The Ansimi app utilizes real-time data from CCTV control centers in 25 districts of Seoul to monitor the user's situation and enable coordination with the police for on-site responses during crises.

Since its launch in 2016, more than 220,000 citizens in Seoul have downloaded the app, and the number of reports through the app has exceeded 36,000. The emergency reporting and safe return service of the Ansimi app is being expanded to local governments across the country and provides services for each local government through a smart city integration platform. This S/W-based service connects crime prevention, transportation, and information systems for each local government as provided by MOLIT.

City / Country	Seoul, Korea	Public ■ Private □ (Local Government)	Service Scope	Seoul

Sector	Safety	Project Launch	2016
Issues to tackle	An increase in crimes that threaten the safety of citizens, including sexual harassment and indiscriminate crimes		
Objective	• To provide safe return services for pedestrians based on real-time reporting and monitoring		
Concept	• A safety app that monitors and coordinates with the police in case of emergencies to ensure that vulnerable groups, such as women, children, and older people, can walk the streets and return home safely with peace of mind		

Key Takeaways

- **Integrated safety service delivery:** The Ansimi app provides services in conjunction with other safety services, such as the Ansim Scout System operated by the Seoul Metropolitan Government and simple reporting functions.
- **Safety service linked to real-time CCTV monitoring:** The Ansimi app uses high-definition CCTV to secure videos and photos of crises and identifies users' locations in real time to enable rapid police intervention.

22 The app is named after 'Ansim,' a noun that stands for feeling relieved in Korean.

Feature	• Easy emergency reporting: Pressing the emergency report button in the Safety App, shaking the phone vertically three or more times, or pressing the volume button three or more times consecutively automatically makes an emergency report. • Safety scout reservation: The Safety Scout Reservation Service, a feature of the Safety App, is linked with Seoul City's Safe Return Scout Service. When citizens reserve a scout through the app, volunteer scouts accompany them home safely. • Providing real-time monitoring using integrated CCTV control centers: The Ansimi app utilizes data from the integrated CCTV control centers in 25 districts within Seoul to offer real-time safety services. By connecting with over 80,000 CCTV cameras located throughout the city and the integrated CCTV control centers, it supports emergency response, real-time monitoring, and ensures a safe return home for citizens.
Major Actors	• Seoul Metropolitan Government: The Seoul Metropolitan Government leads the operation and maintenance of the entire Ansimi system. • Integrated CCTV control centers: The integrated CCTV control center operates 24 hours a day and always has monitoring personnel and police officers on duty. CCTVs are installed in each district in Seoul to monitor any illegal behaviors and ensure facility safety and traffic control. The Ansimi app is linked to CCTV installed for crime prevention. • Police: The police established an organic cooperative relationship with the Seoul Metropolitan Government and the integrated CCTV control center to intervene and support users in danger.
Utilized Technology	• Maps application programming interface (API), Integrated CCTV monitoring, geographic information systems (GIS)
Estimated Cost	• (2017) USD 824,000 → (2018) USD 890,300 → (2019) USD 890,300 Source: Prepared by the author based on the annual Seoul Smart City and Digitization Action Plans
Basic Configuration	
Areas for Improvement	• The app's usability is limited to a specific geographic area, and once it extends beyond administrative boundaries, it may be excluded from the service coverage. • In areas with unstable network connections, the speed and effectiveness of the service may be compromised.

Reference

https://50plus.or.kr/detail.do?id=26895773#
https://news.seoul.go.kr/welfare/archives/517373

4.2. Land and Housing

4.2.1. Toji-eum, South Korea

'Toji-eum[23]' is a comprehensive portal service that provides integrated land use regulations and urban planning information in South Korea. Before the integration of land information, the Ministry of Land, Infrastructure, and Transport operated separate portal services for land use and urban planning information. The Land Use and Restriction Information Service (LURIS), which provides land use planning and restriction information, has been operational since 2007, and the Urban Planning Information Service (UPIS), which offers urban planning and ordinance history information, was launched in 2008. Both portals initially ran concurrently with Toji-eum for the first three months before merging. The scope of the data provided by Toji-eum ranges from urban planning decisions obtained from central and local government agencies and approval of implementation plans for infrastructure facilities such as roads and railways to zoning designations and land zoning history.

Toji-eum offers comprehensive land and territorial information to enhance user convenience. Various information provided by Toji-eum is also available through mapping services and can be compared with satellite maps and viewed using street view in conjunction with mapping services offered by private portals such as Naver and Daum. Toji-eum provides land use plans through GIS services, which allows users to navigate the map, zoom in and out, and perform parcel number searches. Additionally, it offers information on area/zone designations, changes in parcel numbers, and details on land division and consolidation, all of which are part of the land use information.

City / Country	Korea	Public ■ Private □ (Central Government)	Service Scope	Nationwide

Sector	Land	Project Launch	February 2021
Issues to tackle	Inefficient use of land and urban planning information		
Objective	• To enhance public access to national land use information		
Concept	• An integrated land use regulations and urban planning information portal		

Key Takeaways

- **Connection with private portal map services:** Integration with private Korean portal sites, such as Naver and Daum (Kakao Map), allow users to compare land use plans, identify land use restrictions, and view urban planning and the official history of each parcel, along with satellite images and street view.
- **Integrated land and urban planning information:** Toji-eum provides comprehensive land use information, including area/zone designations and removals, land division and consolidation, and land zoning history, along with urban planning information, including detailed implementation plans for urban planning projects. This enables users to make comprehensive use of land use information.

23 The words 'Toji' and 'eum' stand for 'land' and 'connection' in Korean respectively.

Feature	• Integrated data provision: Toji-eum provides a comprehensive set of information, including the history of area/zone designations and removals by parcel number, land division and consolidation details. It integrates official information related to urban and rural planning projects, from project approval to implementation planning, which allows users to easily understand the progress of these projects. • Mapping services utilizing GIS data: It allows for the visual inspection of land use plans and zoning areas in map format. It is also possible to compare land use plans with satellite imagery through integration with private portal site map services. • Provision of land use and urban planning laws and policy information: Toji-eum's users can search and view regulations, guidelines, and planning documents related to land use plans and urban planning by city or district.
Major Actors	• MOLIT: MOLIT aggregates all the data and information for the site and operates it. • Private portal sites: Private portal sites provide mapping services connected to the land information map of Toji-eum.
Utilized Technology	• Maps, API, GIS
Basic Configuration	
Areas for Improvement	• Differences arise between the topographic map and cadastral map. Due to technological limitations, discrepancies may occur between urban planning data based on continuous cadastral maps.

Reference

https://www.eum.go.kr/

http://www.molit.go.kr/USR/NEWS/m_71/dtl.jsp?id=95085122

For Further Information

https://www.youtube.com/watch?v=pZPY6Yeq-YI

4.2.2. Nowon Zero Energy House, Seoul, Korea

As smart cities must be environmentally friendly, the application of appropriate techniques and strategies for reducing energy consumption, sustaining the environment, and managing costs are essential. Nowon EZ House, Korea's first zero-energy multi-unit housing complex, is the result of the "Zero Energy Housing (ZEH) Activation Optimization Model Development and Demonstration Complex Development." The project was completed in September 2017, and the building received a passive-house certification in August 2018 for the first time in the South Korean housing sector from the German Passive House Research Institute.

This house can maintain a comfortable living environment with low energy consumption by using passive design technology for insulation and airtightness. In particular, energy costs are reduced by using renewable energy sources, such as photovoltaic and geothermal systems. By using passive design technology that maximizes insulation performance, 61% of the energy usually required at a home is saved. In addition, utilizing highly efficient facilities, such as heat recovery-type ventilation devices and optimum control facilities, saves 3% additional energy.

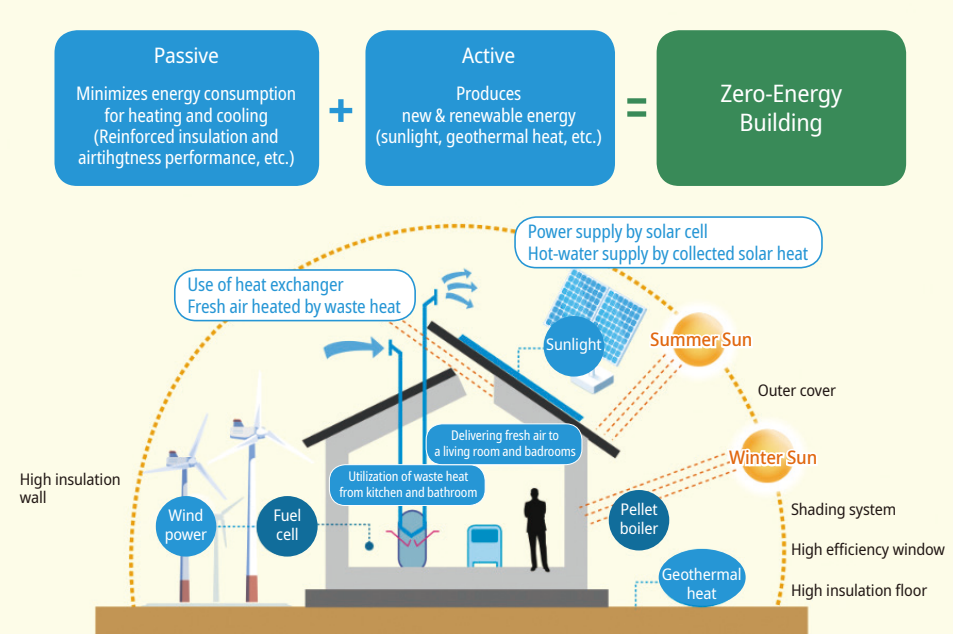
City / Country	Seoul, Korea	Public ■ Private □ (Local Government)	Service Scope	Nowon District in Seoul

Sector	Housing	Project Launch	2013 (Implementation) 2017 (End of Construction)
Issues to tackle	Greenhouses gas emissions from buildings, especially newly built buildings		
Objective	• To minimize energy consumption from buildings		
Concept	• Zero Energy Housing Complex		

Key Takeaways

- **Continuous energy monitoring:** Through an IT monitoring system, a total of 121 households collects extensive data by measuring thousands of data points per minute. The data illustrate the energy efficiency level in this complex, which is accessible not only to residents but also to the public. This model can be readily applied to buildings on a national and city-wide scale following the Zero-Energy Building (ZEB) roadmap in various phases.

Feature	• Development of low carbon cities: Greenhouse gas emissions from buildings can be lowered through optimizing energy equilibrium, and technology facilitates expansion of ZEB as a solution to build low carbon cities. • Multifaced scale of the project: It supports achieving 2050 carbon neutrality target at the national and local levels.
Major Actors	• Project approval and implementation: Seoul City, Nowon District • Project implementation and funding: Korea Agency for Infrastructure Technology Advancement (KAIA), Nowon District • Technical and operation analysis: Kumkang Korea Chemicals Corporation (KCC), Ethics and Compliance (E&C), Myongji University, Seoul Housing and Communities Corporation Research
Institutional Enablers	The national and local governments of the Republic of Korea set a carbon neutrality target by 2050 ↓ Seoul Metropolitan Government (SMG) sets a GHG emissions reduction target of 40% and 70% from the level of 2005 by 2030 and 2040 respectively • Green Building Construction Support Act and Energy Use Rationalization Act • Adopting Ordinance the Support for Construction of Green Building, Energy Saving Design Standard Building, and Green Building Construction Plan of Seoul City ↓ Under the leadership of MoLIT, Zero Energy Building (ZEB) • Laying the foundation, promoting the popularization, and initiating enforcement • Technological solution in reducing GHG emissions from buildings, especially newly-built buildings
Utilized Technology	• Passive technology: Energy-efficient materials were applied to all sides of the housing, encompassing walls, roofs, floors, ceilings, windows, and doors, to minimize energy loss. • Active technology: A total of 1,284 solar panels were placed on the external walls, and 130 geothermal heat pumps were buried underground, both of which contribute to the generation of clean and renewable energy for heating and cooling purposes.
Estimated Cost	• USD 49 million (46.92 and 0.21 million USD for construction and R&D, respectively)

Basic Configuration	 Source: The Ministry of Land, Infrastructure, and Transport
Areas for Improvement	• Malfunctioning technology facilities • Due to inconsistent institutional support, there is a lack of communication between management institutes and residents.

Reference

https://www.schoeck.com/en/case-studies/nowon-energy-zero-house-ez-house

Park Sang Gil 2017, 'Zero energy' apartment house to be constructed in Nowon district... Heating & cooling system without fossil fuel, The Digital Times,

http://eng.dt.co.kr/contents.html?article_no=2017120810352200114 3

http://www.ezcenter.or.kr/

UNESCAP. *Seoul's Nowon Energy Zero Housing Complex: Reducing Building Emissions*

For Further Information

Green Buildings Construction Support Act:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=61436&lang=ENG
Energy Use Rationalization Act:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=61373&lang=ENG

4.3. Mobility

4.3.1. Transport Operation and Information Service (TOPIS), Korea

TOPIS is Seoul's urban management hub, which manages transportation, disaster prevention, and safety in an integrated manner. TOPIS analyzes big data to prevent and predict traffic problems, thereby enabling rapid judgment and response. The TOPIS Integrated Situation room receives information from transportation cards, bus GPS, and CCTV and disseminates it through websites, SNS, and smartphones. It also exchanges data with public agencies in Seoul such as broadcasting stations, regional construction management agencies, and road corporations. Using state-of-the-art equipment, it monitors transportation systems, disasters, and safety conditions in Seoul 24 hours a day and functions to minimize potential damage through a rapid response.

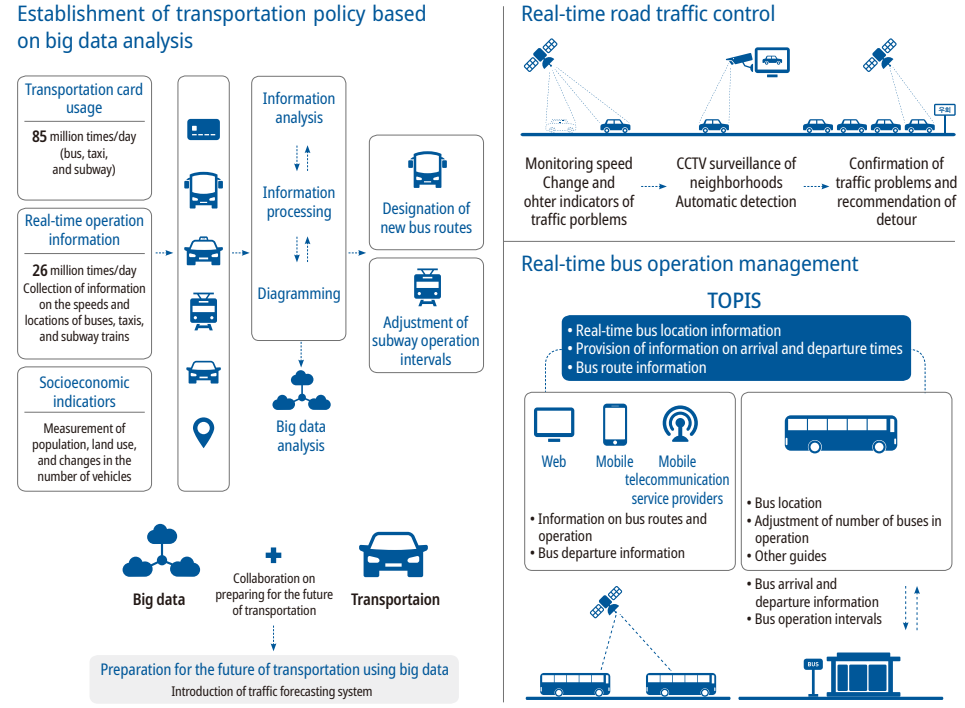
TOPIS also addresses excessive traffic and prevents sudden traffic congestion by collecting bus operation information, the number of transit users, traffic density, traffic flows, traffic accidents and protests, highway conditions, and personal traffic information.

City / Country	Seoul, Korea	Public ■ Private □ (Local Government)	Service Scope	Seoul

Sector	Mobility	Project Launch	2005
Issues to tackle	Emerging need for systematic management of transportation and responding to the increased complexity of the public transportation system		
Objective	To provide systematic management of transportation responding to real-time traffic flow		
Concept	Comprehensive traffic control center that operates and manages all traffic in Seoul		

Key Takeaways

- **Collection and analysis of big data:** TOPIS's big data analysis supports the establishment of more scientific road and public transportation plans. TOPIS's data allows better planning of optimal routes in heavily congested areas and helps adjust public transport routes and subway operation intervals.

Feature	• **Integrated center system:** TOPIS provides 24-hour integrated management of transportation, disaster, and security and utilizes advanced equipment to constantly monitor traffic, natural disasters, and safety-related abnormalities in Seoul and respond quickly to minimize secondary damage. • **Road traffic management system:** TOPIS provides integrated monitoring of real-time communication situations and traffic forecast information on major roads in Seoul and information related to shared bicycles and shared cars. • **Bus Information system:** TOPIS provides real-time bus operation information collected by the Seoul Bus Information System (BIS) through various media (Internet, mobile web, apps, etc.). • **Automatic control and imposition of fines system:** CCTV automatically recognizes traffic violations on bus-only lanes, bicycle-only roads, or illegal parking vehicles and issues fines. • **Big data analysis system:** Big data analysis system of TOPIS analyzes and predicts 85 million transportation card data, real-time operation data, and socio-economic indicators per day and prevents traffic congestion by readjusting bus routes and adjusting public transportation intervals.
Utilized Technology	• Open API, integrated CCTV monitoring, big data, AI video analysis
Basic Configuration	

Reference

Seoul Metropolitan Government. 2017. *Safe, convenient, people-centered transportation in Seoul- Seoul Transportation*

For Further Information

https://topis.seoul.go.kr/

https://smart.seoul.go.kr/

https://seoulsolution.kr/en/content/topis

4.4. Energy

4.4.1. Smart Grid, Sejong, Korea

Sejong is one of the leading smart cities in Korea, and its Smart Green City plan is led by the Multifunctional Administrative Construction City Agency (MACCA). Four public buildings were chosen as test beds in the first town: the office of the community center, postal office, police station, and fire station. The four buildings installed building automation systems (BAS) and building facility management systems for energy efficiency. In addition, light & electricity, geothermal heat, and air conditioning and heating systems were installed separately in each building. For easy control and integration of the BAS, an energy control system (ECS) was developed for each building, and all the data from the four buildings were transmitted to the Energy Operation Center (EOC), which can monitor and control all energy uses simultaneously.

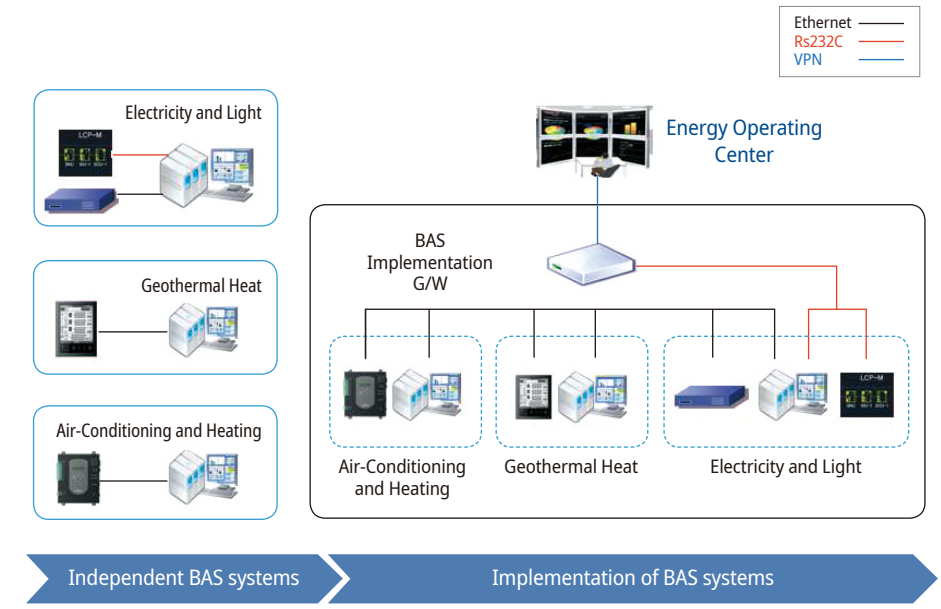
City / Country	Sejong, Korea	Public ■ Private □ (Central Government)	Service Scope	Sejong

Sector	Energy	Project Launch	2012
Issues to tackle	The requirement for customized energy technology for the new city to improve energy efficiency		
Objective	• To provide high quality power and maximizes energy utilization efficiency by using intelligent and advanced electrical grid		
Concept	• Energy saving technology application		

Key Takeaways

- **Technology specialized in energy control:** Developing an energy optimization system with building energy information modeling enables remote management of buildings' energy usage from the EOC, with the expectation of achieving energy savings through monitoring and control. To improve energy efficiency and costs, it developed an open operating system that embodies a data hub model for integrated big data management that connects the energy-related data.

Feature	• Efficient system integration and operation: The power grid combines IT technology with the intelligent energy power trading system in order to increase efficiency of technology response to electricity. • Integrated big data analytics: Through big data analysis, it is possible to monitor the amount of energy being used and to exercise control over energy consumption.
Major Actors	• SProject implementation and funding: Multifunctional Administrative Construction City Agency (MACCA) • Technical and operation analysis: Korea Telecom (KT)
Institutional Enablers	2006 The Korean government passed the Energy Act and the Framework Act on Low Carbon and Green Growth Based on these acts, the government is required to establish a national Energy Master Plan every five years, with a planning period of 20 years According to the Electric Utility Act, MOTIE has to formulate a plan for long-term electricity supply & demand targeting the stabilization of electricity supply and demand The Act on the Promotion of the Development, Use, and Diffusion of New and Renewable Energy requires drafting a basic plan for new and renewable energies including the national strategy for development and use 2010 A comprehensive Smart Grid Roadmap was released in 2010 2011 The Smart Grid Construction and Utilization Promotion Act was enacted in May 2011 The 1st Intelligent Grid Basic Plan was set up in 2012 for the next 5 years 2017 In 2017 the Moon Jae-in government separately disclosed its policy regarding new and renewable energy matters through its New and Renewable Energy Plan 3020 2018 The 2nd plan was published
Utilized Technology	• Building automation system (BAS): Light and electricity, geothermal heat, and air conditioning and heating systems were separately installed in each building. • Energy control system (ECS): For the building's easy control and integration of BAS, ECS was developed in each building. • Graphic user interface (GUI): GUI is a type of user interface that allows users to interact with electronic devices using images rather than text commands. • Digital smart meters: Digital meters were set up to monitor electricity usage in detail on each floor in each building. This allows users to see how much energy is used by the floor and facility. • Counter sensors and motion sensors: When residents pass the door to a room, the counter sensors sense it and turn on the light. • Energy operation center: All the data from the four buildings are transmitted to the energy operation center, where an operator can monitor and control all energy at once.
Estimated Cost	Approximately 2,000,000 USD

Basic Configuration	 Source: Jung, et al.,2013, Korea Micro Energy Grid Technology: The use case of the First-town in Sejong, IEICE(S6).
Areas for Improvement	• A better management system for energy fee collection is needed. • Continuous maintenance by technology experts is essential to check for malfunctions between facilities

Reference

Vincent J. Forte, Jr. 2010. *Smart Grid at National Grid, Innovative Smart Grid Technologies.* IEEE.

SBI Report, 2009, *Smart Grid Technologies Market to Reach S17 Billion.*

Daekyo Jung, Sungmin Rue, Yoonkee Kim, Byungdeok Chung, 2013. *Korea Micro Energy Grid Technology: The use case of the First-town in Sejong,* IEICE(S6).doi:10.34385/proc.17.TS6-3

Miha Jensterle, Regina Yoonmie SOH, Maike Venjakob, Oliver Wagner. 2019. *System Integration of Renewables and Smart Grids in Korea.* Short Scientific Report

Appendix (Information of Related Laws)

Energy Act:

https://elaw.klri.re.kr/kor_service/lawView.do?hseq=61371&lang=ENG

Smart Grid Construction and Utilization Promotion Act:

https://elaw.klri.re.kr/kor_service/lawView.do?hseq=42765&lang=ENG

4.4.2. Smart Grid, Vietnam

Driven by its rapid population growth and evolving consumption patterns, Vietnam has witnessed a consistent increase in energy demand. This has prompted the formulation of strategies and action plans to address the demand–supply energy gap, together with concerted efforts to substantially increase the share of renewable energy in power generation in alignment with the domestic Power Development Plan.

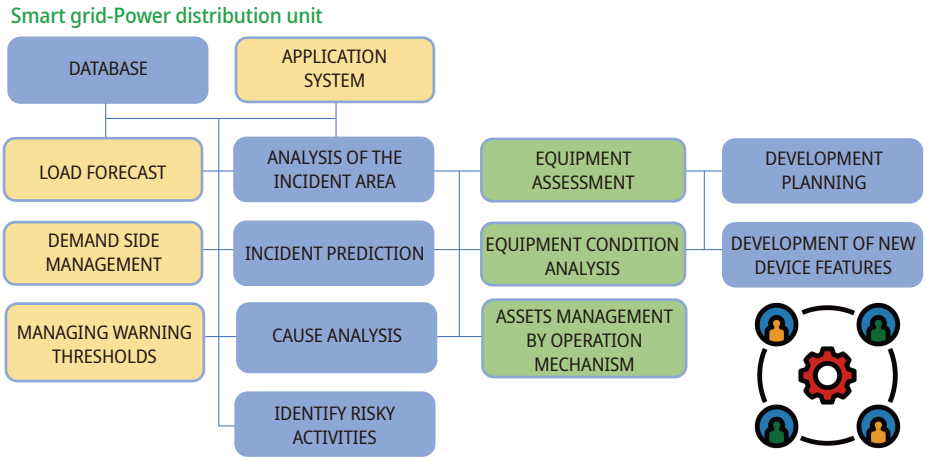
The Smart Grids for Renewable Energy and Energy Efficiency (SGREEE) project, initiated in 2017, aims to enhance the performance of the country's power sector, diminish the need for substantial investments in power networks, and promote more efficient integration of renewable energy sources. This project builds on the strategy endorsed by the government in 2012 to develop a smart grid to modernize the national power transmission system in response to the rapidly escalating electricity demand of the burgeoning economy. The subsequent Smart Grid Roadmap aimed to enhance the system's reliability through demand-side management and energy efficiency measures. To this end, the project aims to foster modernization and automation of the power transmission and distribution system, resulting in a digitized and more flexible national power supply system in Vietnam.

City / Country	Viet Nam	Public ■ Private □ (Central Government)	Service Scope	Nationwide

Sector	Energy	Project Launch	2017–2021
Issues to tackle	Increasing energy demand		
Objective	• To close the electricity demand–supply gap by improving the system's reliability and efficiency		
Concept	• Smart grid application to domestic power plant infrastructure		

Key Takeaways

- **Regulatory framework:** The roadmap established detailed targets, including the legal framework for smart grid development and experts and stakeholders involved in updating the smart grid roadmap. Focusing on renewable energy and energy efficiency, the electricity law provides a basic legal framework for introducing new technologies such as smart grid initiatives in the power system. Consequently, this project now works closely with the Vietnamese power sector to develop a digitized and more flexible power supply system.

Feature	• Integrated policy measures: The interdependencies of policies and regulations related to the energy market were assessed in the context of long-term smart grid development. • Improvement of labor productivity: The development of automatic substations and distribution grid automation have enhanced the power system operation efficiency, reducing power losses.
Major Actors	• Project approval: The Electricity Regulatory Authority of Vietnam (ERAV) of the Ministry of Industry and Trade (MOIT) • Project implementation and funding: The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH with the German Federal Ministry for Economic Cooperation and Development (BMZ)
Institutional Enablers	On November 8, 2012, the Prime Minister of Vietnam issued Decision No. 1670/QD-TTg approving the project "Developing Smart Grid" in Vietnam. The legal framework was extended by new regulations on the following: • Unmanned, automatic substations • Control center for power plants and substations • Technical requirements for renewable energy (wind, solar) • A domestic program for demand-side management and a demand response roadmap and implementation plan • New feed-in tariffs for wind power • Standard Power Purchase Agreements (PPAs) for wind projects • Standard PPAs for solar projects • Mechanisms to promote the development of solar power projects in Vietnam
Utilized Technology	• Supervisory Control and Data Acquisition (SCADA): SCADA is a software application for gathering data in real time from remote locations to control equipment and conditions. In 2018, SCADA systems for power corporations were connected to 99.7% of the power plants with remote metering and 100% of the substations. • Installation of advanced metering infrastructure (AMI): Installation of AMI for large customers was expanded to all power corporations. • Distribution management systems (DMS): New and renewable energy sources were connected to the power system with medium and low voltage levels.
Basic Configuration	 Source: Smart Grid Ecosystem, Tran Cam Linh, EVNHANOI, REV-ECIT 12-202 Source: Huu, N. (2019)
Areas for Improvement	• It takes several years to evaluate system configurations that integrate different technologies and to assess its feasibility in the Vietnam-specific context.

Reference

https://hanoitimes.vn/vietnam-urged-to-update-smart-grid-for-network-reliability-320357.html

https://www.worldometers.info/world-population/vietnam-population/Appendix

APEC SOM Steering Committee on Economic and Technical Cooperation, 2021, *APEC Case Study: Best Practices of Smart Cities in the Digital Age*

Huu, N. 2019. Smart Grids in Viet Nam – Market Development, Frameworks and Project Example

Nguyen Duc Tuyen. 2023. SMART GRID ROADMAP: CURRENT SITUATION AND FUTURE.

4.5. Water

4.5.1. Seoul Water Now System, Seoul, Korea

The Seoul Water Now System is a water quality monitoring system. It monitors the water quality in real time, 24 hours a day, from the source to the tap. Monitors were installed at 200 locations, including intake points, purification centers, distribution stations, pumping stations, parks, and faucets. A full-time monitoring system was introduced to prevent water pollution from harmful chemicals in streams, sewer pipes, and receiving water at water renewal facilities and minimize damage should such contamination occur. The system was designed to monitor and track unauthorized discharge. Monitored water quality is disclosed to the public in real time to enhance the transparency and reliability of the waterworks administration.

City / Country	Seoul, Korea	Public ■ Private □ (Local Government)	Service Scope	Seoul

Sector	Water	Project Launch	2008
Issues to tackle	Protection of water sources		
Objective	• To prevent water pollution from harmful chemicals into the streams, sewer pipes, and receive waters at the water renewal facilities		
Concept	• A smart monitoring system to minimize damage of contamination and track unauthorized discharge		

Key Takeaways

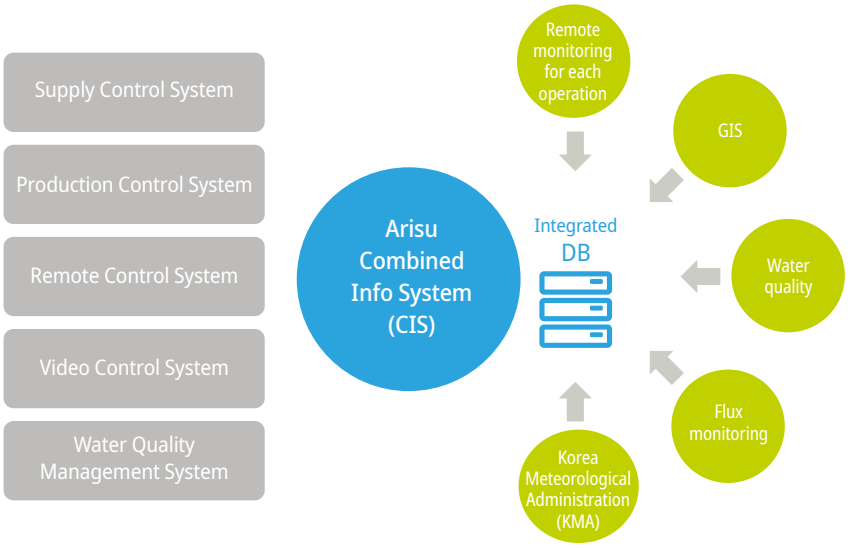
- **Real-time quality check:** The system enables real-time water quality check from water sources to the purification facilities and to the taps used by consumers. It not only serves as a monitoring system for the government to manage the water quality but also provides the public with information on quality of the tap water in real time, which has raised the credibility of the water administration.

Feature	• Real-time monitoring system: A real-time online system shows the number of monitoring water quality parameters and the cleanness of the drinking water. • Data openness: The data and information collected from the 200 sites is open to the public online, where citizens can check the water quality of their community anytime, anywhere through a smartphone application.
Governance	Seoul City

Institutional Enablers

Category	Paldang Reser- voir Protection Area	Special Paldang Reservoir Preser- vation Area	Nature Preserva - tion Zone	Jamsil Reservoir Protection Area	Waterfront Area July 9, 1975
Date Designated	July 9, 1975	July 19, 1990	December 31, 1982	March 20, 1995	September 30, 1999
Legal Basis	Article 5, Water Supply &Water works Installation Act	Article 22, Frame work Act on Envi- ronmental Policy	Article 6, Seoul Metropolitan Area Readjustment Planning Act	Article 5, Water Supply &Water- works Installation Act	Article 4, Act on the Improvement of Water Quality & Support for Residents of the Riverhead of the Han River System
Jurisdiction	4 cities and gun counties in Gyeonggi Province	61 eub/myeon districts in 7 cities and gun counties in Gyeonggi Province	3 gun counties in 5 cities and gun counties in Gyeonggi Province	Upstream of Jamsil Reservoir, Gwangjingu, Songpagu, Gangdonggu, and nearby riverside areas	6 cities and gun counties in Gyeo- nggi Province, 2 cities in Gangwon Province, Chungju in North Chungc- heong Province
Description	Restrictions on fishing, car washing, and other potentially polluting activities in the protected area	Special compre- hensive plan for preservation of upstream reservoir (installation of basic environmental protection facilities, special pollution source management, change of intended use in certain districts	Restrictions on development of sites, industrial lots, and tourist attractions that increase the population	Restrictions on fishing, boating, car washing, and other potentially polluting activities in the protected area	Restrictions on installation of: facilities that gen- erate general and livestock wastewater; accommodations; public bath facilities

Utilized Technology	• Combined Information System (CIS): A real time response and control system that monitors major tap water facilities situations for discussions between different operations.

Basic Configuration	 Source: Seoul Tap Water Arisu
Areas for Improvement	• Regarding technical integration, the water quality parameters in some sites are different because of the source water, and the system sometime fails to check the residual chlorine.

Reference

https://seoulsolution.kr/en/content/3575
https://arisu.seoul.go.kr/sudo_eng/sub/quality/strickWater.j
Seoul Tap Water Arisu, Seoul Metropolitan Government

For Further Information

Water Supply and Waterworks Installation Act:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=60267&lang=ENG
Framework Act on Environmental Policy:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=60971&lang=ENG
Seoul Metropolitan Area Readjustment Planning Act:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=55428&lang=ENG
Act on the Improvement of Water Quality and Support for Residents of the Han River Basin:
https://elaw.klri.re.kr/kor_service/lawView.do?hseq=55771&lang=ENG

4.6. Smart Tourism

4.6.1. Smart Island, Jeju, Korea

Smart tourism refers to the application of ICT for developing innovative tools and approaches to improve tourism. It supports integrated efforts to find innovative ways to collect and use data derived from physical infrastructure, social connectedness, organizational sources, and users, in combination with advanced technologies, to increase efficiency, sustainability, and experience in tourist destinations. The top principles of smart tourism lie in enhancing travelers' tourism experiences, improving the efficiency of tourism resource management, and maximizing tourism competitiveness, with an emphasis on sustainable development.

As one of the most famous tourist destinations in South Korea, Jeju Island has acutely suffered from the negative impact of mass tourism and has been seeking a solution in sustainable tourism to bring about a change from mass to sustainable tourism by adjusting its tourism strategy to the needs of more independent travelers, as well as by fostering a new industrial ecosystem in which new and creative producers can join the residents of the local community. In Jeju, data was collected from the installed free Wi-Fi, including information on the travel routes and stay times of tourists. This data is utilized to enhance the services of online tourism platforms such as VISITJEJU, which provides tourists with information about attractions, accommodations, food, shopping, and local festivals.

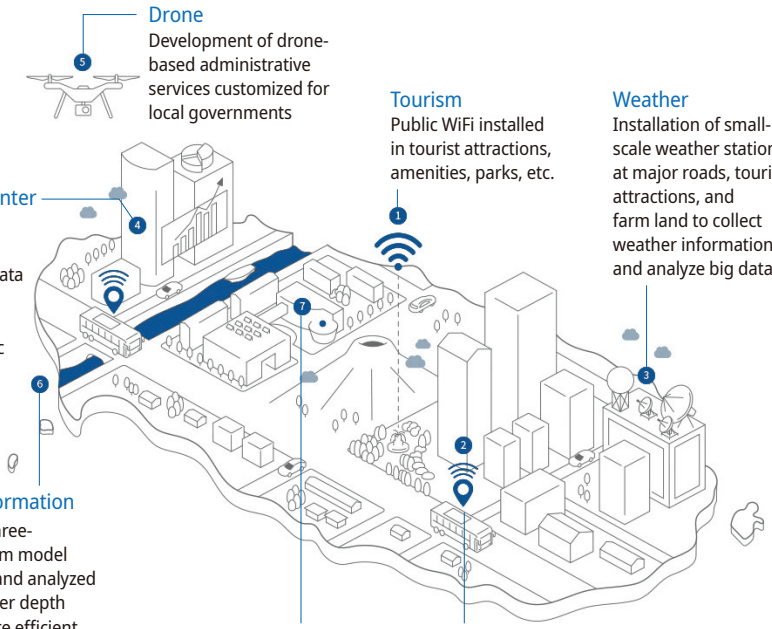
City / Country	Jeju, Korea	Public ■ Private □ (Local Government)	Service Scope	Jeju

Sector	Smart Tourism	Project Launch	2016
Issues to tackle	Suffering from mass tourism		
Objective	• To find a solution for sustainable tourism		
Concept	• Digital governance for effective tourism		

Key Takeaways

- **User-based technology:** The project's strategies are focused on addressing urban issues in the country's largest tourist destination through the analysis of big data to enhance the quality of life of both residents and tourists. The technology used is well-designed, integrating user perspectives with data-based automation and streamlining. These Smart Island strategies particularly promote interaction between massive amounts of data and civil participation in order to pursue sustainable changes and innovation.

Feature	• Big data analysis: Jeju has installed 748 public Wi-Fi networks in the city for everyone to use wireless internet free of charge. Based on data from the installed Wi-Fi, such as locating travel routes and stay time of tourists, Jeju Island analyzed the big data to establish effective tourism policies and develop tourist products.
Major Actors	• Project approval and funding: Korea's central government and the provincial government in Jeju • Project implementation: Jeju Center for Creative Economy and Innovation (JCCI), Jeju Tourism Organization (JTO) • Technical operation: Korea Telecom (KT) corporation
Institutional Enablers	**Purpose** The Jeju Special Self-Governing Provincial Tourism Association was created following the Article 45 of the Tourism Promotion Act on February 22, 1962 to stimulate the growth of the tourism industry in jeju and promote the business and welfare of the association's member companies. **Major Tasks** Overview of business marketing needed to attract tourists Examination and research of jeju's tourism policies Improving accommodation facilities and service quality for tourists Producing tourism statistics Education of tourism workers and their career development Work related to the Travel Agents Mutual Aid Society Performing contracts offered by the central government and local governments Operating tourism informatin offices and promotion centers in Korea Supporting and coordicating the development of tourism businesses Processing complaints by tourists Establishing tourism ethics and guiding clean, safe tourism Source: Jeju Special Self-Governing Provincial Tourism Association website
Utilized Technology	• Free public Wi-Fi deployment without any additional certification and construction of a big data collection system with 180TB capacity build a system to store/analyze big data • Collecting tourist data using Wi-Fi • Building a model to analyze travelers' patterns and a data production system • Systemization to visualize data by establishing an open platform for smart tourism
Estimated Cost	1,000,000 USD

Basic Configuration	 Source: Jeju island website
Areas for Improvement	• Legal issues should be addressed such as data privacy for tourists and data authorization between private and public agencies.

Reference

Adedoyin, F. and An, H., 2017. *Smart Tourism via Digital Governance: A case for Jeju Volcanic Island and Lava Tubes.* Journal of Tourism, Hospitality and Sports, 31, 26 - 39.

Jeju Tourism Organization.2020. Strategy for Sustainable Jeju Tourism

For Further Information

Tourism Promotion Act:
https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=28355&type=part&key=41

4.6.2. Smart Dubai, Dubai, The United Arab Emirates (UAE)

Dubai officially launched 'Smart Dubai' as its smart city concept in 2014. The goal of Smart Dubai is "to become the happiest city on Earth for its citizens, residents, and visitors." As Dubai has gained international recognition as a major tourist destination, it has focused heavily on smart tourism concepts within the Smart Dubai framework to boost tourism.

Dubai's smart tourism initiatives have extensively integrated technology-based solutions into the management of crucial tourism resources, products, and services. These resources encompass major infrastructural components such as airports, hotels, transportation, and the creation of specific products and services designed to enhance the overall experience for tourists. Furthermore, Dubai has developed a range of mobile applications that enhance the happiness of both tourists and residents and contribute to the seamless and efficient provision of resources.

City / Country	Dubai, United Arab Emirates	Public ■ Private □ (Central Government)	Service Scope	Nationwide

Sector	Smart Tourism	Project Launch	2014
Issues to tackle	Growing challenges from mass tourists		
Objective	• To increase the number of tourists with higher satisfaction levels and motivate them to revisit the city		
Concept	• IT transport infrastructure and applications in favor of tourism		

Key Takeaways

- **Multi-level approach:** By utilizing integrated transportation infrastructures and various travel-related applications, users can interact with the system at multiple points for different solutions, all provided through different system-level functional interfaces. While transportation strategies aim to transform Dubai's operating system to autonomous mode by reducing both transportation costs and environmental pollution, smart tourist applications focus on providing services related to tourism and geographical services that encourage tourists to travel around the city.

<table>
<tr><td>Feature</td><td>• Smart application: Through the integration of AI, big data, and user-friendly design, smart tourism mobile apps provide tourists with useful information.
• Integrated transportation system: There are e-smart parking, smart taxi, smart Salik (toll system), smart drive, and other such infrastructure that make use of smart technology.</td></tr>
<tr><td>Major Actors</td><td>• Cross-governmental committee ‘Open Data Committee (ODC)’: Dubai Smart Government Department, Department of Economic Development, Dubai Police, Dubai Roads and Transport Authority (RTA), Dubai Municipality, Department of Tourism and Commerce Marketing, Telecommunications Regulatory Authority, and Dubai Center for E-Security.</td></tr>
<tr><td>Institutional Enablers</td><td><table><tr><th>Year</th><th>Events</th></tr><tr><td>1999</td><td>Dubai ICT Strategy was planned.</td></tr><tr><td>2000</td><td>Dubai e-Government Initiative was announced.</td></tr><tr><td>2009</td><td>Dubai e-Government Department was open.</td></tr><tr><td>2013</td><td>Smart Dubai Higher Committee was formed.
Higher Committee for the implementation of Dubai Smart City was formed.</td></tr><tr><td>2014</td><td>Smart Dubai Executive Committee was formed.
Open Data Gommittee was formed.</td></tr><tr><td>2015</td><td>Dubai Data Law was announced.
Smart Dubai Office was open.</td></tr></table>Source: Khan et al., (2017)</td></tr>
<tr><td>Utilized Technology</td><td>• The collecting technology layer: It is responsible for individuals who use dashboards and related services within a particular environment.
• The service enablement layer: It is about analyzing private and public data, as well as setting up the necessary governance procedures.
• The data orchestration layer: It focuses on the inflow of secure and accessible data at all times.</td></tr>
</table>

Basic Configuration

< Technology projects related to mobility in Dubai >

Name	Content
Uber Airplane Taxi	The city plans four vertiports by Dubai International airport, and it will include two launching pads and four charging points for the flying taxi. Residents and tourists can fly in the aerial taxis as soon as 2026.
Smart Tunnel at Airport Immigration	The Dubai airport plans the smart tunnel project, which allows a passenger to finish the entry within 15 seconds by simply walking through the tunnel without stamping their passport or any other human intervention.

< Popular Mobile Application in Dubai >

Application	Usage
RTA Dubai	This application provides road and transportation information about metro stations, busses, and even taxis. It is one of the most popular application to residents. It also lists tourist places, mails, hospitals and petrol stations.
Dubai Calender	This application is the official listing of all events in Dubai about conferences, concerts, exhibitions, festivals, etc., which is considered the gateway to events in Dubai.
Time Out Dubai	Time Out Dubai is a popular lifestyle magazine. This application provides information about the best options for a good night out, music, restaurants, flims and hotels.
Dubai-Metro	An RTA application provides diverse and rich information to users about Dubai Metro.

Source: Khan et al. (2017)

Areas for Improvement

- Enhancing the integration of subsystem to the overall smart system
- Difficulties of smartphone usage among older adults

Reference

M. Sajid Khan, M. Sajid Khan, Mina Woo, M. Woo, Kichan Nam, K. Nam, & Prakash K. Chathoth, P. K. Chathoth. 2017. *Smart City and Smart Tourism: A Case of Dubai. Sustainability,* 9, -. doi: 10.3390/su9122279

4.7. Waste

4.7.1. Truck-free waste management system, Songdo, South Korea

Solid waste management is a critical urban challenge in many countries, with potentially adverse impacts on public health and the environment. The experience of the Songdo International Business District, positioned adjacent to Seoul on South Korea's west coast, offers insights into building technology-based advanced hardware infrastructures for solid waste management.

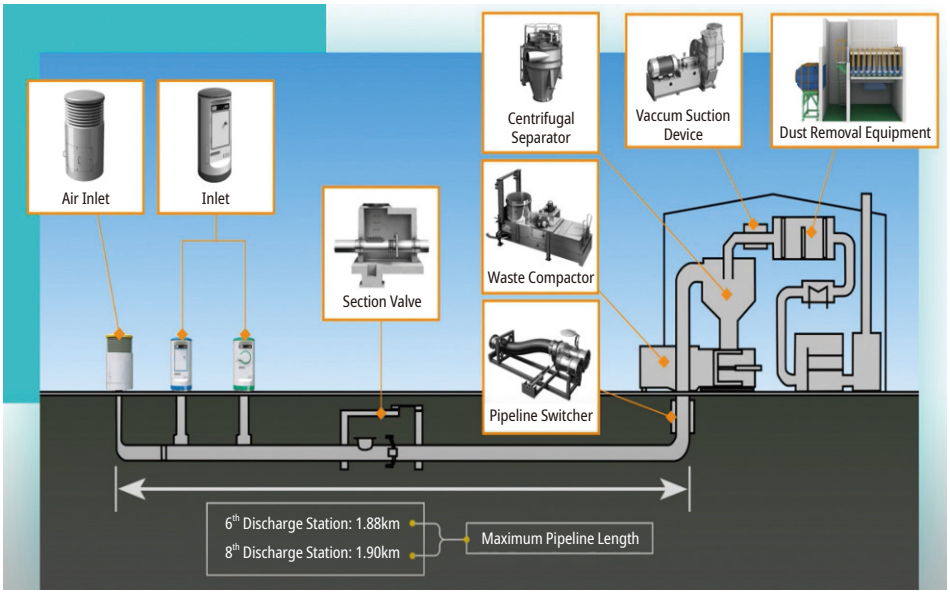
Waste management was considered in the urban planning stage of Songdo, a city built completely on land reclamation with a truck-free waste management system located underground. There are no garbage trucks trawling the streets or vast bins dotted around the blocks of flats. Instead, all household waste is directly transported from automated waste disposal bins situated throughout the city via an extensive underground network of pipes and tunnels to a waste processing center. This waste processing facility is known as the "Third Zone Automated Waste Collection Plant," and it undergoes automatic sorting, deodorization, and treatment to minimize its environmental impact. Furthermore, the waste is automatically sorted and processed for recycling, burial, or conversion into energy. Some key advantages of this system include improved energy efficiency and reduced landfill and energy costs.

City / Country	Songdo, Korea	Public ■ Private □ (Sub-national)	Service Scope	Songdo

Sector	Waste	Project Launch	2003
Issues to tackle	Growing demand for an advanced waste disposal system		
Objective	• To improve the efficiency of the recycling system		
Concept	• A vast underground network of tunnels to waste processing center		

Key Takeaways

- **Transforming waste into resources:** The city's entire waste management system operates underground, where a vast network of pipes processes trash from each individual building while eliminating the need for trucks. The city was built with waste in mind, treating it as a positive resource rather than a problem. Waste is automatically sorted and recycled, and some valuable materials are moved on for reprocessing while others are incinerated to provide energy for the city.

Feature	• Automated sorting system: Recycling infrastructure separates city waste into seven different containers. • Creating an eco-friendly environment: Underground collection tunnels reduce carbon emissions from garbage trucks and make people more conscious of their waste as there are no trash bins on the street. • Ensuring convenience: Automated trash cans are located in the city's apartments, kitchens, halls, and offices.
Major Actors	• Construction and management of the facility: Incheon Free Economic Zone Authority (IFEZA)
Institutional Enablers	The Korean National Assembly passed an Amendment to the Korean Waste Control Act on the following: • Established a set of safety measures for waste-collecting vehicles • Provided more specific safety rules for waste-storage facilities • Authorized the Korean Ministry of Environment to conduct an annual safety inspection and survey on waste treatment business facilities
Utilized Technology	• Pneumatic pipes suck waste directly from premises into an underground network of pipes and tunnels. • The system connects to a central waste processing facility called the "Third Zone Automated Waste Collection Plant." • Waste is automatically sorted and recycled, buried, or burned for energy.
Basic Configuration	 Source: Smart Grid Ecosystem, Tran Cam Linh, EVNHANOI, REV-ECIT 12-202 Source: Huu, N. (2019)
Areas for Improvement	• Technical inconvenience can arise because of aging facilities such as pipes getting clogged.

Reference

https://www.youtube.com/watch?v=dpw8HB2qu7M
https://ie.unc.edu/cleantech-story/designing-sustainable-cities-songdo/
https://www.seequent.com/will-tomorrows-waste-feel-the-pressure/

For Further Information

Wastes Control Act:
https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=43284&type=part&key=39

4.8. Community Empowerment

4.8.1. Make IT Work Project, Amsterdam, Netherlands

The Amsterdam metropolitan region has numerous IT job vacancies. In addition to a shortage of IT specialists, there is unemployment among the highly educated population. The Make IT Work project allows highly educated people without an IT background to retrain for an IT position at the higher vocational education level and start a job immediately.

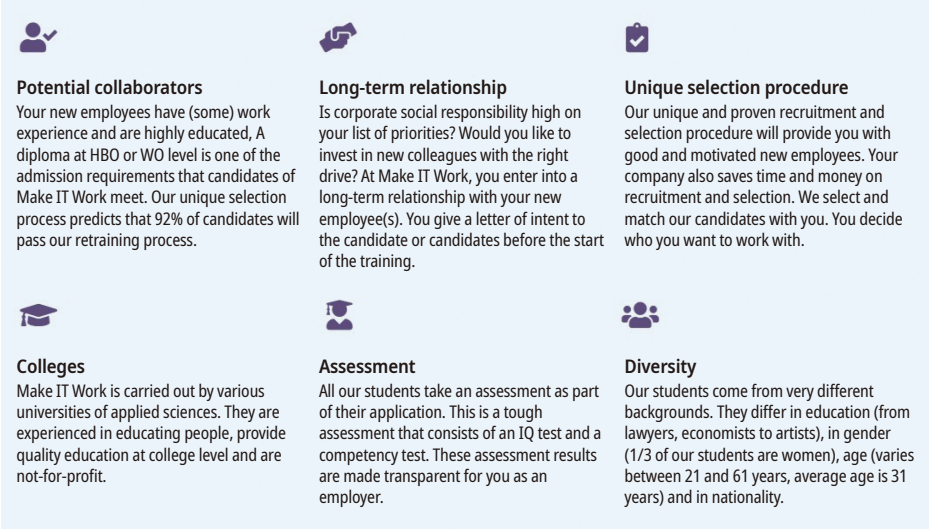
To support this initiative, the Amsterdam University of Applied Science (AUAS) launched an education program that teaches digital skills. Through this project, students can become professional software engineers or business analytics specialists. The project is a joint project with IT companies and institutions, where students receive advanced training once they start working at one of the participating companies. Currently, several universities of applied sciences in the Netherlands are affiliated with the Make IT Work Project.

City / Country	Songdo, Korea	Public ☐ Private ■ (Civil Society)	Service Scope	Amsterdam

Sector	Community and Engagement	Project Launch	2015
Issues to tackle	Shortage of IT specialists		
Objective	• To train students to become software engineers		
Concept	• Training program for prospective IT communities		

Key Takeaways

- **High-level training:** The project develops an educational program that is as up to date as possible and prepares highly educated people without a specific IT background for a career in IT at a higher professional education level with the employers who participate. The program uses a recruitment selection process to match candidates with a future employer, thus helping them to start their new career within the IT industrial field.

Feature	• High quality program: The program offers the trainee quality and state-of-the-art training about business data analysis and software engineering • Sustainable support: Trainees can start working at one of the participating companies or institutions in the second part of the retraining program
Major Actors	• HAN (Hogeschool van Arnhem en Jijimegen) University of Applied Sciences, Amsterdam University of Applied Sciences, IT Academy Northern Netherlands
Institutional Enablers	• AUAS started this initiative in 2015 and participated in this project in support of the Amsterdam Economic Board of the Amsterdam Metropolitan Area and the Ministry of Social Affairs and Employment. • In 2018, the European Commission designated Make IT Work as a model project for teaching digital skills.
Utilized Technology	• Make IT Work acts as an intermediary organization, equipping trainees with IT knowledge and skills to meet the current market demand and connecting professionals and organizations facing IT staff shortages.
Basic Configuration	 Source: Make IT Work website
Areas for Improvement	• Limited opportunities due to solely concentrating on advanced education levels and job positions

Reference

https://www.nederlanddigitaal.nl/initiatieven/make-it-work
https://it-omscholing.nl/programmas/business-data-analytics/

4.8.2. iHub, Kenya, Nairobi

iHub Nairobi is a network and meeting place that enables Kenya's innovators to bring ideas to life. Founded in 2013, it was the first hub in Africa to facilitate the progression of technologies from the idea stage to real products. Through iHub, a technology community, industry, academia, investors, and venture capitalists meet, share ideas, collaborate, and turn these ideas into action with the help of an in-house support unit.

iHub is approximately 70% self-funded, largely through research, consulting, and User Experience Lab functions. The remaining 30% is generated through corporate partnerships and events. iHub Nairobi has developed several corporate partnerships with companies such as Intel, Ajaysung, Omidyar Network, Ushahidi, National Media, Google, Zuku, and Hivos. These partners do not act solely as sponsors but are also actively involved in the hub, providing value-added to the community.

City / Country	Nairobi, Kenya	Public ☐ Private ■ (Civil Society)	Service Scope	Worldwide

Sector	Community and Engagement	Project Launch	2010
Issues to tackle	A lack of technology hubs in Kenya		
Objective	• To catalyze the growth of the Kenyan technology community by connecting people and supporting startups and surfacing information		
Concept	• Nurturing business leaders in local technology		

Key Takeaways

- **Engagement of diverse communities:** This organization aims to encourage the growth of African technology entrepreneurship by facilitating conversations relevant to the pan-African IoT community and its ecosystem. It also achieves this goal by developing market-relevant solutions and staying ahead of the curve in terms of innovation.

Feature	• Diverse communities: Collaboration within the community is the driving force for the iHub, and it allows members to work with diverse stakeholders, ranging from individuals to entire large companies.
Major Actors	• Governed by a board of advisors from the Nairobi technology community and partnerships with Facebook, Goggle, Oracle, Safaricom, The World Bank, and Seacom
Utilized Technology	• Inspiring and supporting startups and the community of technology entrepreneurs • Helping schools and students use technology in smart ways to improve learning outcomes in science, technology, engineering, and mathematics (STEM) education
Estimated Cost	• Google provided funding of 150,000 USD to support the community.
Basic Configuration	01 Digital Security Across Kenya and Nigeria, we are supporting marginalized communities and groups, including persons with disabilities and senior citizens to get involved in the digital revolution. We do this through our DIGnified and ICT Democracy programs through which we have empowered over 140 men, women and young people (and counting) to become digital citizens   02 Online Etiquette As good as the internet is, it can be an enabler for threats and issues like cyberbullying, identity theft, revenge porn and so on to its users With our online etiquette programs, we are changing the narratives by educating young people across universities to see and approach the internet differently in a way and manner that builds and supports rather than abuse and tear down. We do this through education and user awareness campaigns around privacy, internet best practices, data protection, digital security, online identity, and so on In addition, we are building a pan-African awareness platform that takes user awareness of online issues to multiple African countries 03 Digital Literacy Across Kenya and Nigeria, we are supporting marginalized communities and groupe, including persons with disabilities and senior citizens to get involved in the digital revolution. We do this through our DIGnified and ICT Democracy programs through which we have empowered over 140 men, women and young people (and counting) to become digital citizens   04 Internet Freedom We are one of the leading internet freedom voices and advocates on the continent Working with other key organisations like CIPESA, Amnesty International, Article 19 and Paradigm Initiative under the African Internet Rights Alliance (AIRA), we are supporting the creation of an Africa the digital rights of her citizens are protected and respected Source: https://ihub.co.ke/
Areas for Improvement	• Because 70% of the project's budget comes from internally generated revenue, additional support from both local and central governments is needed. • Difficulty in monitoring the program's consistency

Reference

https://ihub.co.ke/

https://www.theguardian.com/world/2012/oct/30/kenya-silicon-savannah-digital-technologyhttps://www.theguardian.com/world/2012/oct/30/kenya-silicon-savannah-digital-technology

https://www.worldbank.org/en/news/feature/2018/11/01/ihub-world-bank-to-showcase-20-promising-digital-entrepreneurs-and-locally-relevant-innovations-from-east-africa

https://www.worldbank.org/en/programs/competitiveness-for-jobs-and-economic-transformation/brief/about-infodev

4.9. Public Management and Urban Services

4.9.1. mVoting, Seoul, Korea

The Seoul Metropolitan Government (SMG) has created a modern democratic environment by introducing a mobile app, 'mVoting' which can effectively involve citizens in policy decision-making process. The name mVoting[24] combines two words: mobile and voting. The application is user-friendly and accessible on both smartphones and personal computers. The policy goals of mVoting are: 1) sharing the policy decision-making process with citizens, 2) promoting citizen participation in policy determination, and 3) increasing the quality of public services provided by SMG.

This application promotes a transparent policymaking process through the disclosure of information, the facilitation of citizen participation, and engagement in specific policy issues. Additionally, under the concept of 'prosumers,' which considers Seoul citizens as active contributors to policy, it enhances public performance by promoting citizen participation. This participatory policy enables citizens to express their opinions on policy issues and on daily matters of city life.

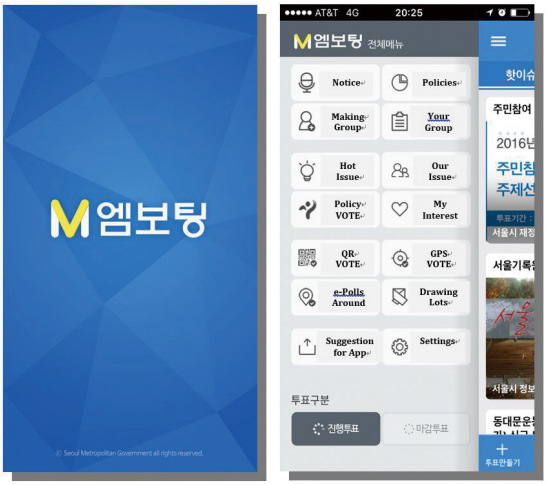
City / Country	Seoul, Korea	Public ■ Private □ (Local Government)	Service Scope	Seoul

Sector	Public Management and Urban Services	Project Launch	2017
Issues to tackle	The inconvenience of collecting citizens' opinions		
Objective	• To encourage citizens to participate in the policy decision-making process		
Concept	• Mobile voting application		

Key Takeaways

- **Time and cost-effective systems:** The mVoting technology allows citizens to electronically submit and vote on local policy proposals using their mobile devices. This application reduces the cost of voting, such as time and economic costs incurred when holding policy meetings with small committees, board members, and various departments.

24 The app's name is a combination of the terms 'mobile' and 'voting'.

Feature	• **Open vote for everyone:** Regardless of which department in SMG is involved, the SMG officers can request a vote when Seoul citizens' opinions are required. • **Targeted vote in specific context:** Based on the existing Seoul database, mVoting offers the option of opening a targeted vote to specific citizens depending on age, municipality, job, and gender. The targeted voting system enables SMG to generate specific policies and store the demographic data regarding specific agendas.
Major Actors	• Seoul Metropolitan Government (SMG)
Institutional Enablers	2011-2015 Smart Seoul Promotion: Smart Seoul 2015 plan establishment Beautiful comprehensive infrastructure, "Various citizen participation, information foundation, big data" 2007-2010 u-Government: Ubiquitous-Seoul Masterplan established 2005-2006 Seoul Electronic Government Expansion: One-click electronic civil complaints service, e-Tex, public transportation system enhancement 2003-2004 Seoul Electronic Government Official Publication: Establishment of secondary information master plan/Integration and linkage of information resources and e-governement infrastructure 1999-2002 Electronic Government Preparation: Amendment in Seoul information-oriented fundamental ordinance, 1st information-oriented basic plan established, enlarging infrastructure in administration, urban, living, and industry Source: Seoul Solution website
Utilized Technology	• **Location Based Vote with GPS, registration and QR code:** Policies are related to a location's unique context such as traffic signs and city hall events. To resolve a locational-specific issue, mVoting provides a GPS-based vote (e.g., to citizens who are within a radius of two miles)
Basic Configuration	 Source: Seoul Solution website
Areas for Improvement	• Minor malfunctioning while using the mobile application • Inclusion of the older generation, who are not familiar with using mobile apps

Reference

https://www.seoulsolution.kr/en/content/3467

https://seoulsolution.kr/en/content/%E2%80%98mobile-voting-app%E2%80%99-m-voting

4.9.2. Tokyo Digital Twin Project, Tokyo, Japan

A digital twin is a 3D virtual recreation of a space in the real world. Digital twins initially emerged to optimize processes, enhance quality, and anticipate risks, primarily in the manufacturing sector. In general, technology promises to help optimize and expand the activities of businesses and individuals. It can also prompt greater efficiency and more advanced urban management with key features including 1) simulations and analyses that are difficult to conduct in real spaces, 2) feedback on the planning and operation of real spaces, and 3) collaboration spanning real and virtual spaces.

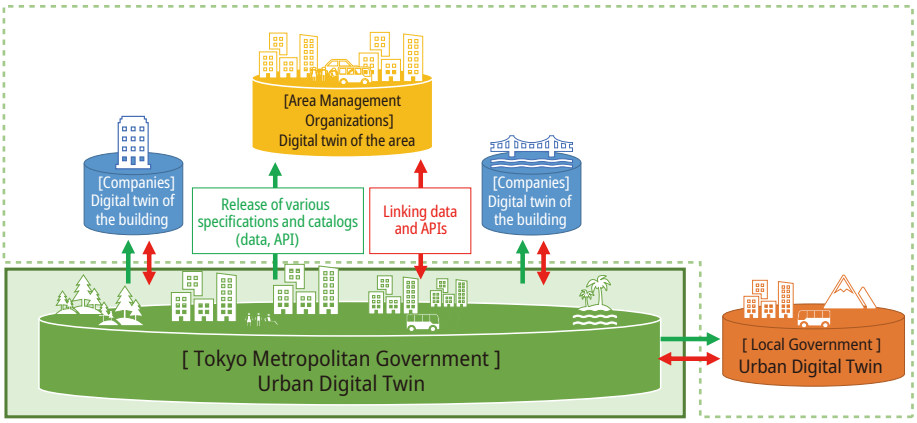
To address the declining population and increasing severity of natural disasters in the Tokyo metropolitan area, the Digital City project aims to provide a digital twin-city environment. This involves handling a 3D urban environment dataset and establishing a visualized environment with local digital city activities, all of which contribute to the construction of a responsive urban management system. Since 2023, the Tokyo Metropolitan Government has been conducting several pilot projects to verify the utilization of real-time data acquired by sensors, manage data, and establish data linkages with industries, academia, and government entities.

City / Country	Tokyo, Japan	Public ■ Private □ (Local Government)	Service Scope	Tokyo

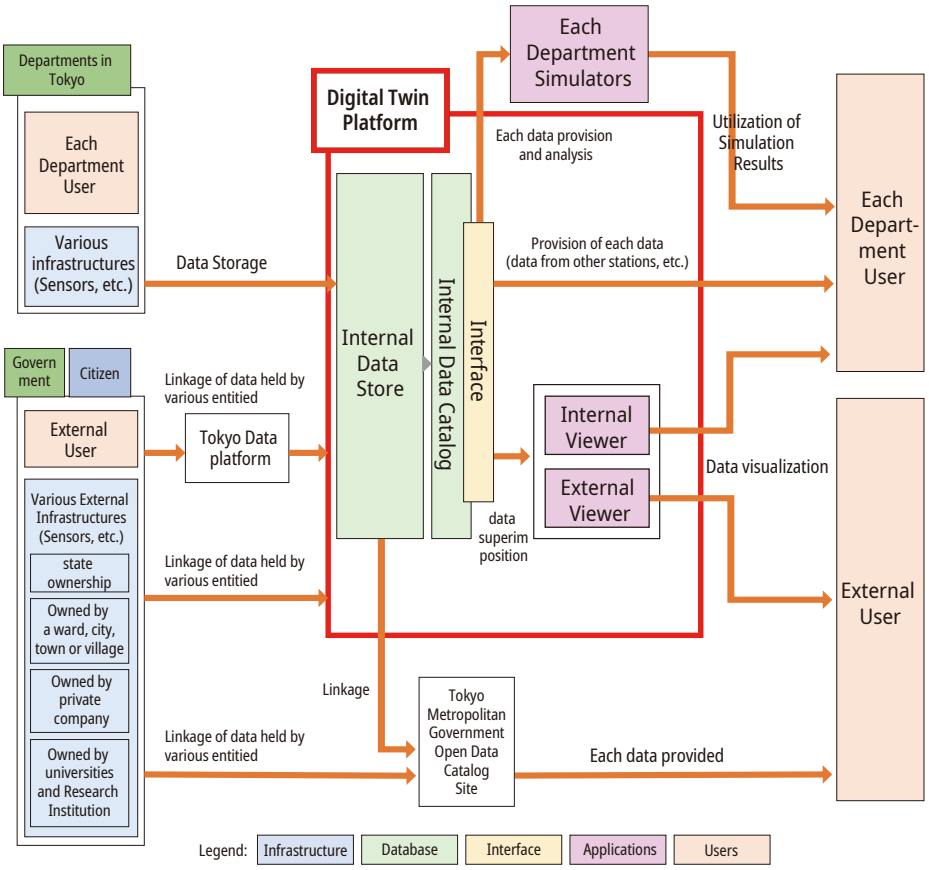
Sector	Public Management and Urban Services	Project Launch	2021
Issues to tackle	The delayed response of the urban management systems to unexpected situations		
Objective	• To obtain a real-time understanding of urban conditions in physical space in cyberspace		
Concept	• Reproduction of a physical space in cyberspace to simulate data for various purposes		

Key Takeaways

- **Flexibility:** The use of a 'digital twin' reproduces a real space in virtual space to take advantage of the limited movement of people around the world. Because there are no physical limitations in the virtual space, the use of a digital twin makes it easier and convenient to conduct various tests.
- **Efficiency of management:** When issues that need to be addressed occur in urban areas, it is possible to quickly identify the issues by examining the data in the virtual space.

Feature	• Low level of risk: Simulation in a virtual space reduces the level of risks in the real world. It allows operators to test and simulate any actions without bearing any significant danger or problem in real life. • Smooth operation: When an error occurs in the manufacturing line, it is possible to identify the cause by examining the data in the virtual space. • Cost saving: While prototyping or testing is an essential process, it is expensive to operate all in real space. The digital twin enables these processes in a virtual space at a low cost.
Major Actors	 Step 1: Establish and operate a Digital Twin within the Agency Step 2: Mutual Collaboration Source: Tokyo Metropolitan Government, 2022
Institutional Enablers	Examples of items to consider regarding rules and specifications were defined. Source: Tokyo Metropolitan Government, 2022
Utilized Technology	• Floating people analysis and 3D modeling of underground facilities • Verification for 3D map update and user feedback with smart phones • Data acquisition and feedback with smart phone Light Detection and Ranging (LiDAR) function

Element	Examples of items
Laws and regulation	Law and regulations regarding data acquisition and the creation of the digital twins
	Law and regulations regarding data analysis and simulation
	Law and regulations regarding the release of data and the provision of services
Terms and guidelines	Rules for data maintenance and acquisition
	Rules for providing and using dat
	Rules for operating the digital twin platform
Standard Specification	Standard for data format
	Standard for data quality
	Specifications for the tool and operations rules

Basic Configuration	 Source: Tokyo Metropolitan Government, 2022
Areas for Improvement	• To enhance the precision of virtual space outcomes, more advanced network failure classification models should be developed.

Reference

Tokyo Metropolitan Government. 2022. *Tokyo Metropolitan Government Tokyo Digital Twin Project Roadmap for the Social Implementation of Digital Twin First Edition.*
https://www.mri.co.jp/en/knowledge/mreview/202210-2.html

4.10. Health

4.10.1. COVID-19 Response with ICT, South Korea

ICT played a significant role in dealing with COVID-19 in South Korea. The latest information on COVID-19 is constantly updated on national and local government websites. The government also uses smartphone applications to provide information about flagged infection hotspots, with text alerts on testing and local cases. Mobile devices and smartphone apps are also used to support early testing, contact tracing, and monitoring of people under self-quarantine.

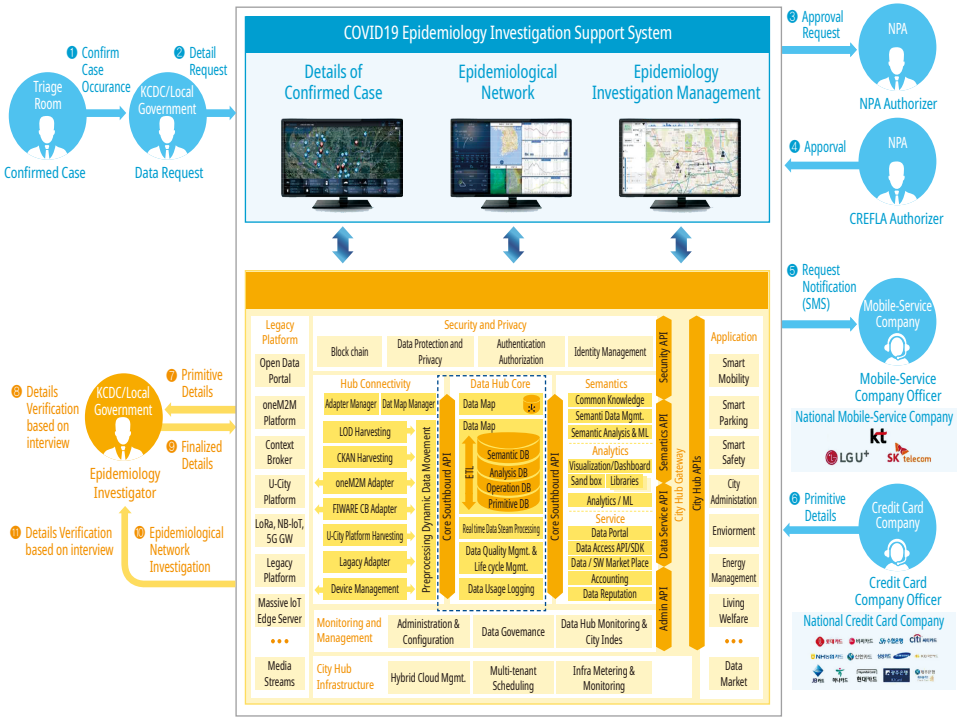
In Korea, contact tracing is divided into four stages: investigation, exposure risk assessment, contact classification, and contact management. To collect information about the patient's whereabouts, ICT is used if supplementary information is needed owing to memory omission or inconsistencies in collecting objective information. Medical records, cellular global positioning system (GPS) data, credit card transactions, and CCTV footage are collected. The collected data are strictly protected to prevent privacy infringement. The figure in the table shows the contact tracing approach.

City / Country	Seoul, Korea	Public ■ Private □ (Central Government)	Service Scope	Nationwide

Sector	Health	Project Launch	2020
Issues to tackle	Rapid spread of an infectious disease, COVID-19		
Objective	• Effective management of COVID-19 to confirm cases and prevent the spread of COVID-19		
Concept	• Remote healthcare system utilizing IT technology and data-driven management of confirmed cases		

Key Takeaways

- **Utilization of digital technology and big data in epidemic investigation and self-quarantine:** South Korea boasts an exceptionally high smartphone adoption rate, with over 95% of the population using smartphones as of 2023. Leveraging this, the South Korean government employed smartphone apps for self-isolation measures during the COVID-19 pandemic. Additionally, the effective utilization of vast amounts of urban data, including credit card information, enabled proactive responses to COVID-19 through efficient epidemic investigations.

Feature	• **Remote medical care:** South Korea implemented remote medical consultations to effectively manage the health of COVID-19 confirmed or suspected cases during the COVID-19 spread while also containing the spread of the virus. • **Self-diagnosis and self-quarantine safety apps:** The Korean government developed self-diagnosis and self-isolation safety apps to ensure effective health management of COVID-19 self-quarantine individuals and prevent the resurgence of the virus. • **These apps were designed in two types:** one for individuals in self-quarantine and another for self-quarantine managers (government officials). App users can conduct self-diagnosis twice a day and the results are sent to the dedicated government officials automatically. Users' location information is managed based on GIS, and an alert is sent to the manager app if users deviate from the designated location for self-isolation. • **Epidemiological investigation using urban data:** The COVID-19 epidemiological investigation system was based on refined data sources such as mobile communication, credit cards, and quick response (QR) codes. It mapped out the movements of confirmed cases on a geographical basis, aiding epidemiologists in analyzing their routes.
Institutional Enablers	• **Personal information use:** The Infectious Disease Control and Prevention Act - Strictly caution must be employed when using personal information • **Universal Coverage of National Health Insurance**
Utilized Technology	• **Infrastructure w/ smart city:** Analyzing credit card history data and location information by Smart City Data Hub • **IT-based applications:** Self-diagnosis app and self-quarantine safety app • **E-Government System:** Integrated support from 28 public agencies.
Basic Configuration	 Source: MOLIT. 2020. COVID-19 Smart Management System.

Reference

Sang hoon Lee 2020. *COVID-19 Smart Management System in Korea* (Presentation)

https://dgovkorea.go.kr/service1/g2c_03/self_safe_app

The Government of the Republic of Korea. 2020. Flattening the curve on COVID-19: How Korea responded to a pandemic using ICT. Retrieved from https://smartcity.go.kr/wp-content/uploads/2019/08/Flattening-the-curve-on-COVID-19.pdf

4.11. Climate Change and Environment

4.11.1. Environmental Monitoring Car, Copenhagen, Denmark

The Ministry of the Environment of Denmark monitors and analyzes the atmospheric content of many compounds, such as sulfur dioxide (SO_2), nitrogen dioxide (NO_2), lead, carbon monoxide (CO), and ozone (O_3). Anchored by Copenhagen Solution Lab, the Air-View car, developed by Utrecht University, monitors street-level air pollution. When a large amount of information is analyzed and validated with support from universities, such as those in Copenhagen and Aarhus, the data are released to the public by politicians and scientific communities. Google has also joined this effort by providing street view cars equipped with air quality sensors to collect air quality data for every street in Copenhagen.

The measurements target the pollutants emitted in the city, particularly NO2, ultrafine particulate matter, and black carbon. A significant supplement to this measurement is model simulation, which can provide important information on the possible effects of new interventions to control pollution levels. These calculations also provide a more detailed picture of the geographical distribution of pollution. The project publishes final maps of air pollution in the city, providing ultrafine particle concentrations measured at the street level. Street-by-street maps provide practical and actionable insights for urban planners and policymakers.

City / Country	Copenhagen, Denmark	Public ■ Private □ (Local Government)	Service Scope	Copenhagen

Sector	Climate Change and Environment	Project Launch	2018
Issues to tackle	Traffic air pollution		
Objective	• To monitor the air quality and control the pollution level		
Concept	• Street view vehicle gathering data fitted with advanced air quality measuring equipment		

Key Takeaways

- **Region-specific data:** Creating a fine-meshed network that displays pollution levels down to the street level and covers all roads throughout the entire city made the differences very clear. This creates a dataset which can map hyper-local, block-by-block emissions and particle pollution.
- **Utilizing existing technology:** With a simple yet innovative technological combination, it uses Google street view vehicles equipped with scientific instruments that measure air quality at the street level.

Feature	• Hyper-local data: The project marks the first time the city has been able to measure the concentration of ultrafine particles down to the street level. • Interconnectivity: The information collected allows for the identification of correlations between human activities, infrastructure, and air pollution.
Major Actors	• Project funding and implementation: The Ministry of the Environment, Copenhagen Municipality, the University of Utrecht, the University of Aarhus, Google, and the Copenhagen Solution Lab
Institutional Enablers	• Danish requirements for air quality are all based on provisions adopted by the EU. Most important Danish legislation on air pollution control • September 6, 1972: Limits to sulphur in oil • June 13, 1973: Environmental Protection Act entering on force in 1974 pnovides for environmental approval and reduction of pollution from industrial enterprises. • June 21, 1977: Regulation of lead in petrol. • March 24, 1963: Limit values for atmospheric contents of sulphur dioxide and particulates. • May 23, 1984: Reduction of sulphur dioxide from power plants. • March 12, 1987: Limit values for atmospheric contents of nitrogen dioxide. • Decembenr 10, 1987: Regulation of approved waste incineration plants. • April 5, 1989: Reduction of sulphur dioxide and nitrogen oxides from power plants. October 1. 1990: Requirement for catalytic converter in new private cars. • October 15, 1900: Reduction of emissions of sulphur dioxide, nitrogen oxides and particles from large combustion plants. • January 4, 1991: Regulation of waste incineration plants. • March 11, 1994: Limit values for atmospheric contents of ozone. • September 14, 1998: Reduction of air pollution from tractors, contractors' equipment etc. • September 17, 1998: Tax on suilphur. • July 9, 2001: Limit values for atmospheric contents of sulphur dioxide, nitrogen dioxide, nitrogen oxides, lead and particulates. Source: Danish Ministry of the Environment
Utilized Technology	• It engaged Google to monitor hyper-local air quality (each street monitored three times per year) providing deep insights on risks. • Street view cars, equipped with high-precision GPS drive around the cities, capturing 360-degree photos for Google Maps
Basic Configuration	 Source: Sacyr, Waste Management Facilities Reference
Areas for Improvement	• Time-consuming process to collect data

Reference

https://eng.mst.dk/air-noise-waste/air/air-pollution-monitoring-programme/
Danish Ministry of the Environment. 2003. *Clean air-Danish efforts.*
https://www.eurisy.eu/stories/copenhagen-mapping-air-pollution/
https://sustainability.google/operating sustainably/stories/airview/

4.11.2. Project SIATA, Medellín, Colombia

Bogotá's Flood Early Warning System, Sistemas de Alerta Temprana Inclusivos ante Inundaciones SATI, Bogotá, Colombia as a pioneering project in the city's disaster risk management efforts. As a collaborative endeavor between the Flood Risk Management Unit (UGRM) and the National Meteorological Institute of Colombia (IDEAM), SATI employs cutting-edge technology and data analysis to bolster the city's readiness for potential flooding events. Its foundation was built on transparency, offering comparative flood risk data to the public in 2014. However, SATI goes beyond data sharing and incorporates internal information from regions, clinics, and physicians to facilitate precise and tailored improvements in flood risk management.

A standout feature of SATI is its remarkable ability to issue timely flood warnings driven by machine learning algorithms and continuous data analysis. This predictive capability has enabled life-saving evacuations and property protection. A notable example is the successful prediction of a significant flood in the San Francisco River area in 2022, where proactive evacuation spared the residents from harm.

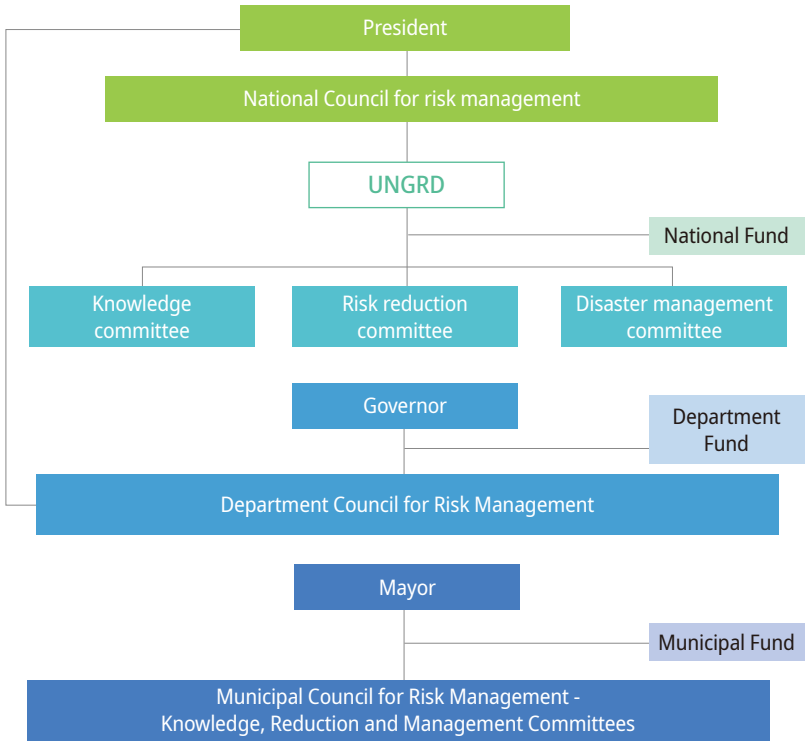
Furthermore, SATI represents a pivotal component of Bogotá's broader strategy for enhancing public safety and resilience in the face of climate change. Continuously evolving and expanding its capabilities, SATI serves as an example of how technology and data can be harnessed to address pressing urban challenges. With its unwavering focus on data exchange and continuity of care, SATI ensures that Bogotá remains at the forefront of flood risk management, offering invaluable insights for other cities aspiring to prioritize disaster preparedness and climate resilience.

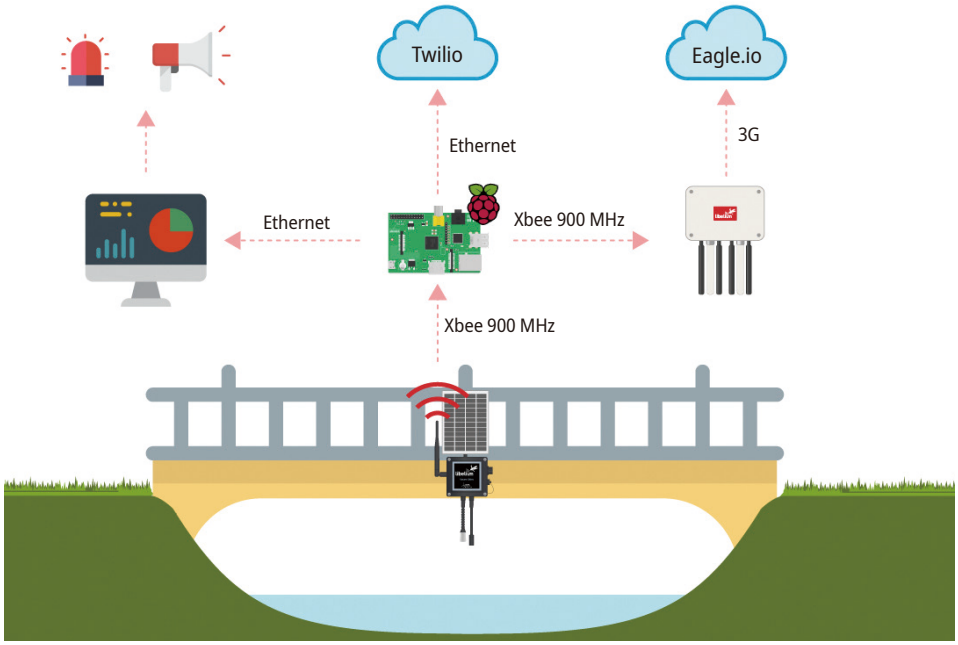
City / Country	Bogotá, Colombia	Public ■ Private □ (Local Government)	Service Scope	Bogotá

Sector	Climate Change and Environment	Project Launch	2014
Issues to tackle	Bogotá's vulnerability to natural hazards, including flooding		
Objective	• To enhance the flood preparedness and response of Bogotá		
Concept	• Early flood warning system		

Key Takeaways

- **Effective multi-stakeholder partnerships:** Early warning alerts through active collaboration and data sharing among the private and public entities in meteorological sectors.
- **Ease of service expansion:** Relatively simple flood warning systems through sensor installations, enabling similar implementations across various local governments.

Feature	• **Advanced machine learning for flood prediction:** SATI employs cutting-edge machine learning algorithms to predict floods accurately, utilizing real-time weather and river data. • **IDEAM collaboration for precision:** SATI collaborates with IDEAM to access the latest meteorological data, ensuring precise and timely flood warnings. • **Enhancing public safety:** SATI's main goal is to enhance public safety by issuing early flood warnings, reducing risks, and protecting communities.
Major Actors	• Collaborative governance led by UGRM (Unidad de Gestión del Riesgo de Desastres y Cambio Climático) and IDEAM (Instituto de Hidrología, Meteorología y Estudios Ambientales).
Institutional Enablers	 Source: Estructura de la Unidad Nacional para la Gestión del Riesgo de Desastres (UNGRD) (con base en: UNGRD, 2014)
Utilized Technology	• **Data processing and analysis:** It collects and prepares real-time data for accurate flood predictions. • **Algorithm selection and development:** Machine learning algorithms are carefully chosen and fine-tuned to improve prediction accuracy. • **Warning issuance and communication:** Automated warnings are issued promptly to authorities and the public to enable timely responses to potential flood events.
Estimated Cost	10,000,000 USD

Basic Configuration	 Source: Communications diagram - Libelium Comunicaciones Distribuidas S.L
Areas for Improvement	• Data integration and exchange • Developing more advanced information-sharing systems such as an app for issuing early warnings is necessary

Reference

FUNDACIÓN ASOCIACIÓN PARA LA COOPERACIÓN Y DESARROLLO COMUNAL DE EL SALVADOR (CORDES). 2019. *Guía práctica: Sistemas de Alerta Temprana Inclusivos ante Inundaciones* (SATI). https://asb-latam.org/wp-content/uploads/2020/02/Manual-SATI.pdf

C. Morales, Y. Sánchez, M. Mehrvar, E. Quiñones, G. Santos and G. Acero, *Flooding Risk Assessment of the Sewerage Risk Management Unit 251 of Zone 2 of Bogota, Colombia.* 2022. Congreso Internacional de Innovación y Tendencias en Ingeniería (CONIITI), Bogotá, Colombia, 2022, pp. 1-6, doi: 10.1109/CONIITI57704.2022.9953665.

IFRC. 2023. *Colombia: Floods - Operation Update,* Appeal No. MDRCO022 [Situation Report]. ReliefWeb. https://reliefweb.int/report/colombia/colombia-floods-operation-update-appeal-no-mdrco022

Unidad Nacional para la Gestión del Riesgo de Desastres. 2016. *Guía para la implementación de sistemas de alerta temprana comunitarios.* Bogotá, D.C.

4.11.3. Project SIATA, Medellín, Colombia

Project SIATA is a groundbreaking initiative that reshapes how disaster preparedness is approached in Medellín, a bustling city in the Aburrá Valley of Colombia. SIATA stands for the Early Warning System of Medellín, and the Aburrá Valley represents a comprehensive and integrated approach to disaster monitoring, prediction, communication, and education. Project SIATA embodies the fusion of technology, community involvement, and proactive disaster preparedness, thus laying the foundation for safer and more resilient Medellín and Aburrá valleys in the face of evolving climate challenges and natural hazards.

At the core of Project SIATA is a sophisticated monitoring and prediction system. It continually tracks critical meteorological, hydrological, and air quality variables in real-time owing to strategically placed sensors throughout the region. SIATA also places strong emphasis on engaging the community in disaster preparedness. Through educational campaigns and workshops, the project familiarizes residents with the system and imparts essential knowledge on how to respond effectively to warnings. By encouraging active citizen participation in monitoring and reporting local conditions, SIATA has added an extra layer of vigilance to disaster preparedness.

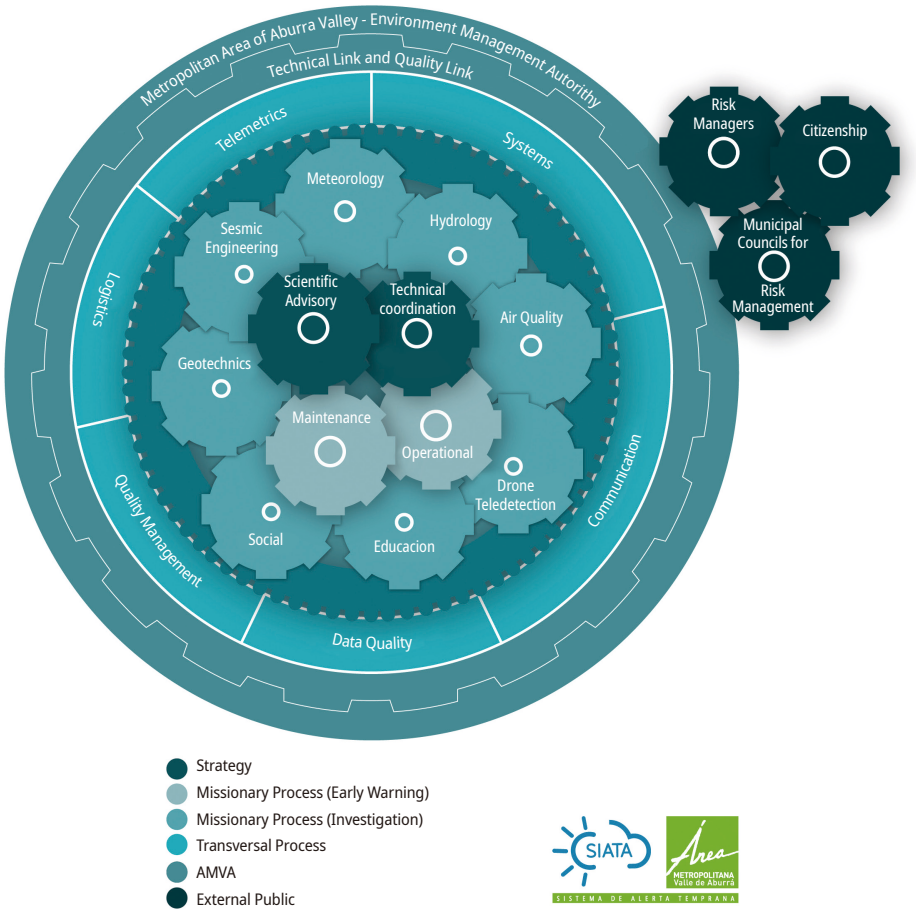
City / Country	Medellin, Colombia	Public ■ Private □ (Local Government)	Service Scope	Medellin

Sector	Climate Change and Environment	Project Launch	2014
Issues to tackle	Vulnerability to the natural disaster of Aburrá Valley and Medellin		
Objective	• To enhance disaster preparedness and response of the Medellin government.		
Concept	• Integrated early warning and disaster resilience for urban safety including real time monitoring and open access data portal		

Key Takeaways

- **Real time monitoring and open access to the data:** Open access to SIATA's portal allows citizens to get real time information on air pollution, extreme weather, flooding, and earthquakes.
- **Local community empowerment:** SIATA not only provides early warning and disaster prevention services but also works to strengthen risk knowledge processes through education and dissemination strategies to achieve democratization and social appropriation of science, technology, and innovation, an exercise that strengthens the social process based on *Sistemas de Alerta Temprana Comunitarios* (SATC), a community early warning system, where communities in the city are key actors. Also, by hiring community members as volunteers for real time monitoring.

<table>
<tr><td>Feature</td><td>• Real-time monitoring: SIATA enables real-time monitoring of hydrometeorological variables and atmospheric conditions.
• Data accessibility: SIATA ensures data accessibility through a mobile application and website for weather forecasts, alerts, and precipitation patterns.
• Community engagement: SIATA conducts education and communication programs to increase community awareness and participation in disaster preparedness.</td></tr>
<tr><td>Major Actors</td><td>• Local government, research universities, community networks, and Aburrá Valley authorities.</td></tr>
<tr><td>Institutional Enablers</td><td>
<table>
<tr><th>Laws and regulations that apply to the SIATA project</th><th>Institutional enablers</th></tr>
<tr><td>Law 99 of 1993 (General Environmental Law): This law establishes the general principles and guidelines for environmental management in Colombia. The law requires the Colombian government to take steps to prevent and mitigate environmental damage.</td><td>The Metropolitan Area of the Aburrá Valley (AMVA): The AMVA is a public entity that is responsible for coordinating the planning and development of the Aburrá Valley region.
The AMVA played a key role in developing and implementing the SIATA project.</td></tr>
<tr><td>Law 1523 of 2012 (Disaster Risk Management Law): This law establishes the National System for Disaster Risk Management in Colombia. The law requires the Colombian government to take steps to reduce the risk of disasters and to respond to disasters when they occur.</td><td>The Mayor's Office of Medellín: The Mayor's Office of Medellín is responsible for the administration of the city of Medellín. The Mayor's Office of Medellín provided financial and technical support for the SIATA project.</td></tr>
<tr><td>Law 1581 of 2012 (Data Protection Law): This law establishes the legal framework for the protection of personal data in Colombia. The law requires organizations that collect and process personal data to take steps to protect the data from unauthorized access, use, disclosure, alteration, or destruction.</td><td>Medellín's Public Enterprises (EPM): EPM is a public company that provides public services, such as water, electricity, and telecommunications, to the city of Medellín.
EPM provided technical support for the SIATA project and operates the network of monitoring stations.</td></tr>
<tr><td>In addition to these laws and regulations, the SIATA project is also subject to the policies and procedures of the Metropolitan Area of the Aburrá Valley (AMVA) and the Mayor's Office of Medellín.</td><td>The Colombian government: The Colombian government provided financial and technical support for the SIATA project.
The World Bank: The World Bank provided financial and technical support for the SIATA project.</td></tr>
</table>
Source: Laws and regulations that apply to the SIATA project.
</td></tr>
<tr><td>Digital Infrastructure</td><td>• Geostationary operational environmental satellite (GOES) antenna: Antenna for receiving information from the meteorological satellite of the National Oceanic and Atmospheric Administration (NOAA)
• Micro radar: Radar that sends electromagnetic wave to the zenith and receives a response that allows determining the presence of water vapor or liquid present up to 3.5 m high
• Weather radar: The type C radar that collects information regarding clouds and precipitation in the Aburrá Valley and the neighboring region
• Wind profiler radar: Radar that allows monitoring the vertical structure of the winds in the Aburrá Valley through electromagnetic waves that interact with the humidity presents in the atmosphere</td></tr>
<tr><td>Utilized Technology</td><td>• Censor technology for environmental monitoring
• Real-time data collection and analysis
• Mobile applications for disaster alerts
• Meteorological radar and remote sensing
• Air quality monitoring and thermal cameras</td></tr>
</table>

Basic Configuration	**Process Map:** Early Warning System of Medellín and of the Aburrá Valley  Source: Process map – Early Alert System for Medellín and El Vale de Aburrá
Areas for Improvement	• Strengthen community relationships • Expand educational programs • Enhance open data processes

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CHAPTER 5

Conclusion

Globally, there is a growing interest in adopting smart solutions to resolve serious urban problems by utilizing rapidly evolving digital technologies. However, because each city faces unique challenges depending on its financial status, legendary information systems, and urban culture, it is difficult to develop a standardized smart city implementation roadmap. Instead, benchmarking cases that have been promoted elsewhere and exploring their potential applicability will be more effective and useful for finding the best-fit solutions for a specific city from among a plethora of smart city services.

This catalog is an attempt to assist such benchmarking processes, particularly for developing countries and cities, by presenting diverse smart city experiences in two categories: sector-specific and cross-sectoral cases. Cross-sector cases in three domains—institutional, technical, and financial—should be considered when promoting publicly driven projects, preparing strategies, and implementing upstream roadmaps. Most importantly, establishing a legal foundation from an institutional perspective should be the foundation of a smart city strategy. The establishment of smart city laws provides a basic framework for the progression of project implementation. The law can also support the development of a national master plan, the implementation of national pilot projects, and the promotion of the Challenge Project to encourage local government participation, as has been the case in South Korea. Developing a standardized integrated information platform through R&D by the central government and distributing it to local governments to secure national interoperability and compatibility should be considered when promoting smart city projects at the national level.

Cities can become smart cities through digitization, digitalization, and digital transformation processes. This progressive and step-by-step implementation ensures substantial and long-lasting effects. Developing a successful business model to maintain the sustainability of smart city businesses is essential for the prosperity of the smart city industry. Finally, policies are necessary to establish an information and communication network to encourage active citizen participation and enhance various living laboratory activities and incentives.

Because most smart city projects require long-term commitments with sustainable financial plans, it is extremely important to refer to and learn from existing cases to minimize trial and error, find optimal solutions, and build successful business models. This catalog can be the first step toward finding ideas for designing and implementing successful smart city strategies and projects.

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