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Smart City Strategies—Technology Push or Culture Pull? A Case Study Exploration of Gimpo and Namyangju, South Korea

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Abstract: This study aims to address strategies, models, and the motivation behind smart cities by analyzing two smart city project cases in medium-sized cities, i.e., Gimpo and Namyangju in South Korea. The case of Smartopia Gimpo represents a top-down, infrastructure-focused smart city innovation that invested in building state-of-the-art big data infrastructure for crime prevention, traffic alleviation, environmental preservation, and disaster management. On the other hand, Namyangju 4.0 represents a strategy focused on internal process innovation through extensive employee training and education regarding smart city concepts and emphasizing data-driven (rather than infrastructure-driven) policy decision making. This study explores two smart city strategies and how they resulted in distinctively different outcomes. We found that instilling a culture of innovation through the training of government managers and frontline workers is a critical component in achieving a holistic and sustainable smart city transformation that can survive leadership changes.

Keywords: big data; cultural change; data analytics; IoT; smart cities



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1. Introduction

The “smart city” is becoming one of the most compelling tools for local governments who are seeking to meet sustainable development goals, achieve a higher quality of life for residents, improve government efficiency, and bring about collaborative governance.

City governments are required to modernize their operations and management to tackle persistent urban problems and respond to society’s complex needs. A smart city approach allows city officials to make more informed decisions. Smart city projects worldwide over the past ten years have increasingly involved the merging of a great variety of city data and technologies. The cities of London, New York, Amsterdam, Paris, and Reykjavik were ranked as the top five smart cities by the IESE Cities in Motion Index in 2019 [1]. Big urban cities pioneered the smart innovation movement; as such, a smart city is often perceived as an “urban labeling” phenomenon [2–5]. Smart city projects, however, are not limited to big and high-tech regions. Smart cities can encapsulate the attributes of diverse cities and communities, regardless of their size and technological capacities.

The one-size-fits-all cliché does not apply to smart city innovations. There is the conception that technology dictates the degree of smartness of a city; however, a smart city should not seek to transform a city into a machine. In conjunction with a given city’s characteristics, smart city initiatives may be implemented on distinctive scales and in particular areas of interest. A realistic smart city model can be developed by feasible practices. South Korea has led technology-driven smart city initiatives with well-equipped infrastructures since the early 2000s. Korean smart city policies have been characterized into three periods: the construction stage (2003–2013), connecting stage (2014–2016), and enhancement stage (2017–2020) [3]. In the first stage, the U-City Act in 2008 supported the construction of technologically advanced infrastructure to improve competitiveness and quality of life in new towns. In the

second stage, smart city policies focused on integrating independently operated information and systems into comprehensive smart city platforms based on U-city solutions. The final stage facilitated the expansion of technology-centric concepts to participatory governance, reforming legal frameworks, and customizing smart city projects by reflecting the specific needs of each city [6]. Local governments in South Korea have mostly embraced new business models resulting from the implementation of smart city concepts.

As a remarkable advancement of the e-government state, in 2016, the Korean government announced the next level of the “e-government 2020” initiative with a vision of “Enjoy your e-Government”. This initiative required that city governments be efficient and transparent by incorporating the ideas of citizen experiences, intelligent government, and digital new deal [7]. This vision promoted a paradigm shift, from an information society to a hyperconnected one. The technical characteristics of the information society were limited to a two-dimensional definition of the compression of the time and space of communication between individuals, while it enabled connection regardless of time and place [8]. In the digital revolution era, the hyperconnected society is based on the Internet of Things (IoT), big data, AI technology, and urban analytics [9,10], empowering cities to move forward in a more connected and smarter way.

The smart city concept has evolved through different types of endeavors corresponding to city-specific characteristics and environments. Gimpo and Namyangju, located in Gyeonggi Province, South Korea, have undertaken exemplary smart city projects. Their extensive experiments have succeeded in turning ambitious visions into realistic plans. As medium-sized cities, both can provide context-dependent insights that help other cities implement smart city initiatives. This study explores the smart city practices and policies of Gimpo and Namyangju to address three research questions: (i) Why do cities pursue this approach? (ii) What are the smart city strategies? and (iii) How do cities implement their smart city plans. Additionally, this study investigates the future challenges facing smart cities. An in-depth case study allows this study to analyze the reality of smart city development and frameworks that have responded to local needs and integrated localized experiences.

2. Landscapes of Smart Practices

2.1. Definitions

The smart city concept has been popular for around two decades, and has continued to evolve thanks to recent technological advancements, such as digitally enabled devices and data architectures, thereby broadening its capacity to achieve sustainable development and improve the living standards of local communities. Early research on smart cities was primarily embedded in the fields of sustainability, digital technology, or knowledge in the 1990s and the 2000s. It was not until the 2010s that the smart city concept became recognized as its own distinct field of research. Since 2008, the quantity of research on smart cities has grown exponentially [11]. The smart city concept is connected to existing intelligent infrastructures, networks, and information, alongside accountable, collaborative, and participatory values. Furthermore, big and open data play critical roles in transforming city systems into smarter systems to boost the efficacy of limited resources [12] and allow better decision making. Open real-time data can improve transparency and provide opportunities for developers creating apps and services.

The modern smart city has been defined in a multifaceted way, based on its primary components, ranging from technical infrastructure to social capital arrangements. As the smart city definition provided by IBM highlighted the use of all related information available to advance limited resources, its smart city strategy focused on building integrated data and analytic platforms to improve efficiency and collaboration among government agencies [12]. Corresponding to IBM’s view, the majority of studies in this domain have focused on the components of the related technology, referring to smart cities as networks of sensors, smart devices, real-time data, or the integration of information technology and communications (ICTs) [13–15]. However, these industry-driven definitions

of smart city approaches have been criticized because technologies should be adapted to empower citizens, and not vice versa [16].

Exemplary smart city projects in various countries have been implemented. Barcelona's high-tech smart city concept aimed to build a sustainable, greener city, innovate commerce, and improve the standard of living [17]. Like the Barcelona case, the Vienna smart city project also focused on the standard of living, resources, and innovation aligning with specific goals [18]. The Vienna case emphasized stakeholder participation in order to narrow the gap between implementation and the vision of stakeholders. In the design of a smart city framework, the key components are weighted differently, depending on cities' priorities. Smart cities are always on, and are readily accessible, information-rich, interactive, secure, and transparent [7]; their evolution may be customized to empower citizens, communities, and society in general.

2.2. Characteristics of Smart Cities

In a broad sense, smart cities integrate three elements, namely, technology, people, and institutions; most studies have identified these factors as the core characteristics of a smart city [19–21]. The technology aspect includes all intelligent, virtual, ubiquitous, and information paradigms [19], so the quality of ICTs and other physical infrastructures is critical to support better smart city practices. Aiming for a technology-enabled city is fundamental [3]. The dominant research field for smart cities is ICT disciplines, such as computer science, engineering, electronics, and information systems [9]. These technological notions overlap with the meanings of the term 'smart,' defined as intelligent or knowledgeable [15,22]. With the advancement of ICTs, smart city connectivity and the integration of the tremendous quantities of data generated by physical and networked devices [20] have been the focus of recent attempts to define smart cities. The intelligence of smart cities involving big data analytics, modeling, and visualization improves operational and institutional processes for better decision making [15] and the integration of the IoT [23].

The human outlook of smart cities overlaps with creative, human, learning-, and knowledge-based city models [24], as a smart city aims to serve citizens by providing a high standard of living [5,25]. An early study proposed that population growth and human capital were associated with the growth of smart cities, as an educated populace provides information and knowledge to residents about all aspects of their lives [26]. Networked cities promote positive relational connections between citizens and other technological and institutional components to advance the quality of human capital. As creativity is a core characteristic of smart cities, a climate for education, learning, and knowledge is necessary to create social capital [27]. Smart cities can be thought of as the capacity of smart people to create solutions to problems [4]. Recent discussions raised social exclusion issues that addressed some the lack of access to smart city solutions among certain citizens [27].

The institutional perspective of smart cities features community governance and growth to share interests and engage a broader range of stakeholders in the decision-making process [17]. The construction of smart cities has governance implications as well as socio-technical arrangements; as such, collaborative relationships among all stakeholders are vital in determining the success or failure of a smart city projects [28]. The roles of the stakeholders in smart city projects have often been examined using the triple helix conceptual model [29–31]. A digitally connected city promotes a citizen-centric approach that empowers citizens to satisfy their needs in decision-making processes. Although smart city strategies prioritize relational and participatory characteristics, their practices are mostly directed according to the perspectives of the providers. Focusing on smart city services from the perspective of citizens [32–34] is necessary to enhance smart city practices.

2.3. Smart City Models and Dimensions

The smart city has been considered a solution for many prevailing economic, social, and environmental problems, as well as for future development challenges. Recent smart city initiatives have diversified to design cities to provide innovative ser-

VICES to citizens and businesses via internet-based applications [24]. The public service perspective emphasizes the role of local governments to develop new smart city business models, because smart city projects require collaboration with other service providers. From the service perspective, public–private partnerships are essential to building a smart city. In the early 2010s, a case study on the city of Seoul reported that 93% of its smart city plans had been initiated by the central government [32]; in comparison, 50% of those of San Francisco City were initiated through public–private partnerships [32]. It is up to each city to determine a suitable degree of public–private partnerships, depending on the stage of smart city development. Top-down initiatives limit work with the private sector, while bottom-up initiatives tend to broaden the involvement of businesses. Once smart city progress has matured, market-oriented partnerships may be needed for sustainable smart city growth and governance [32].

Smart city business models enable local governments to elevate citizens and community governance values beyond simple cost-driven aspects. A systematic review identified eight driving factors in the construction of smart cities in developing countries: economic and financial capacity, technology and infrastructure readiness, the strengthening of regulatory development, human capital, citizen participation, partnerships with the private sector, and the creation of a supportive ecosystem [35]. These are not so different from the driving factors behind smart city plans in developed countries, even though technologies are the most critical factor in developing countries.

Smart city operational systems are interconnected for greater efficiency. Studies have identified six dimensions to describe a holistic approach for smart city models: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance [3,25,36–38]. Smart governance describes the participation of a diverse array of stakeholders in decision making and in public services to promote democratic values. In this case, proactive citizen and community participation is essential to reshape city services. These dimensions are not independent; the main components of a smart city are the community, transportation, energy, water, and healthcare. The sector-specific approach of smart city initiatives allows cities to effectively implement their strategies [18]. A smart community is coupled with other components to run a smart city project more efficiently and effectively, which delivers benefits to citizens.

3. Data and Methods

The present research includes a descriptive case study of two city projects, i.e., Smartopia Gimpo and NamYangJu (NYJ) 4.0. The case study is predominantly focused on ‘why’ and ‘how’ questions in order to analyze complex links of events or behavior; the author felt that applying a case study approach could deepen our understanding of smart city behavior [39,40] in terms of its goals, objectives, main actors, and strategies. Context-dependent knowledge and experience can be gleaned from both cases [41]. Data were collected from multiple sources (e.g., interviews, communications, observations, documents, and project data) from January 2016 to July 2018 for Gimpo, and from December 2017 to November 2018 for NYJ.

For Gimpo, the author participated in more than 30 advisory meetings and communicated with the relevant stakeholders (e.g., the Vice Mayor, the CIO, Big Data specialists, the Gimpo Big Data Corporation, and other relevant public officials) to build a disaster safety platform over the study period. Regarding NYJ, a series of interviews with NYJ public officials (e.g., the Big Data task force team, the Vice Mayor, the Mayor, a Big Data specialist, other relevant public officials) were conducted in order to discuss the operations and impacts of the NYJ 4.0 projects. The Vice Mayor was initially interviewed in December 2017, and interviews with the Mayor and other officials followed in January 2018. After the NYJ 4.0 projects had progressed further, a follow-up interview was conducted with the city’s Big Data specialist in November 2018.

Gimpo City is located in the middle west of South Korea, bordering Seoul to the east and the demilitarized zone to the north (see Figure 1). In 2018, the population was

427,754. The total area is 276.61 km², consisting of three municipal level divisions, 3 Eup, 3 Myeon, and 6 Dong. The City of Gimpo is growing fast with the vision of a ‘Sustainable and Creative City,’ including a citizen- and service-oriented city administration. Its 2018, its annual budget was 1.2 billion USD. Namyangju City is located in the middle west of South Korea, bordering Seoul to the west and the demilitarized zone to the north. In 2018, the population was 1.5 times larger than that of Gimpo, at 674,771, consisting of 1 Eup, 4 Myeon, and 3 Dong. The total area is 458.03 square kilometers, and its 2018 annual budget was 1.4 billion USD.

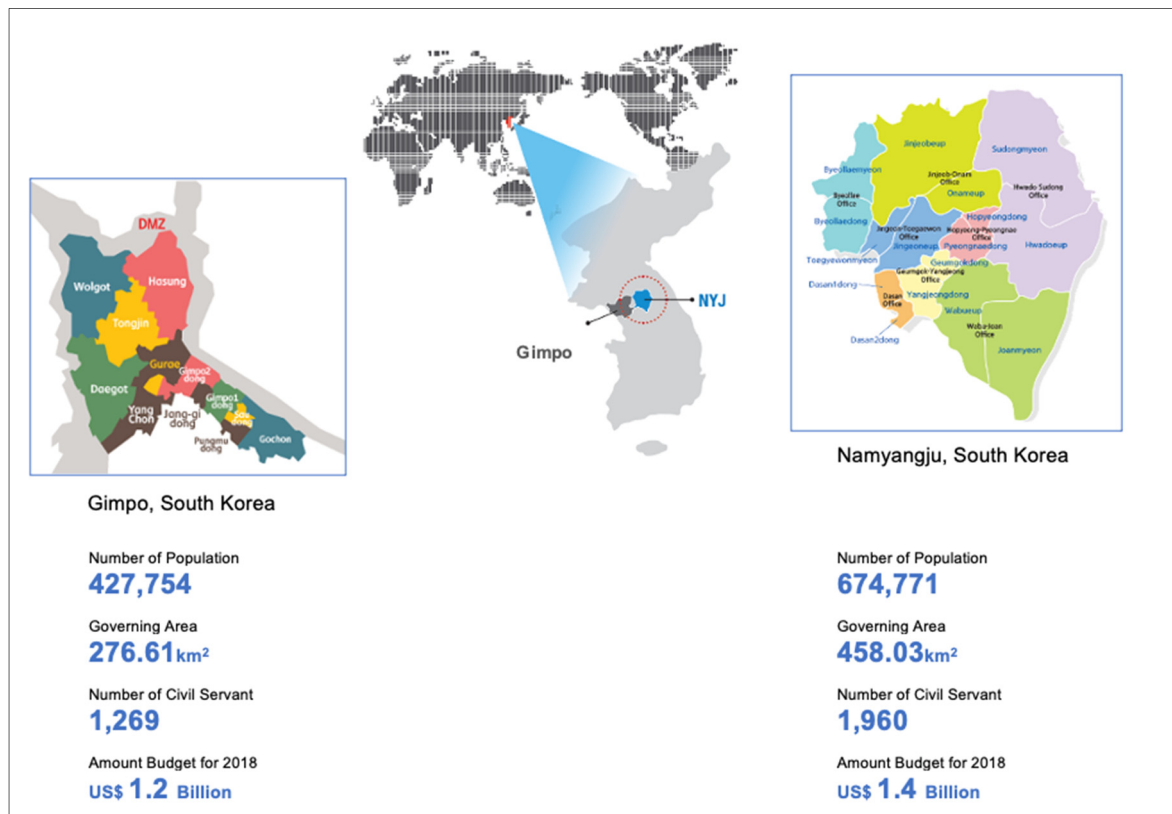


Figure 1. Gimpo and Namyangju (source: Gimpo and Namgyangju).

4. Results

4.1. Smartpotia Gimpo

4.1.1. The Motivation Behind Smart Cities

A hyperconnected society is always on and is readily accessible, information-rich, and interactive, and creates a close connection between people, things, and events. [10,42]. With this in mind, Gimpo City built the Smartopia Center in 2014 through the convergence of ICT technology and created a public–private corporation to improve urban efficiency and ensure citizen safety. As an intelligent integrated city platform, the project “Smartopia Gimpo” with a budget of 40 million USD intended to provide big data-based safety services focusing on crime prevention, traffic, environment, and disasters.

4.1.2. Building a Platform: Smartopia Center

Smartopia Gimpo is an integrated city management facility, called the Smartopia Center (see Figure 2), equipped with a big data city control system consisting of an intelligent CCTV system and a multi-image analysis solution. The primary function is to ensure efficient city management by providing preemptive information on disaster safety and providing smart resident services. It is a real-time, big data service platform based on the IoT, cloud computing, big data, and mobile technologies. This platform makes it

possible to evaluate the signs of risks of natural and social disasters in advance through big data analysis, enabling citizens to cope with risk in advance and minimize their damage. Smartopia Gimpo resulted in decreased crime rates, and fewer accidents and disasters.



Figure 2. Smartopia center (source: Gimpo).

The Gimpo smart city project built an ICT platform to collect, analyze, and provide data to connect and manage urban infrastructure. This platform was constructed according to a business strategy based on an open platform, i.e., the open IoT convergence smart city platform standard model, and a governance partnership in which various producers, users, and operators could participate. Mostly, a newly planned smart city needs to break away from existing network structures which are centered on empowering telecommunications companies. The platform infrastructure also featured related systems with a focus on safety.

4.1.3. Structures and Strategies

Gimpo City established a public–private collaboration platform connected with the national ICT strategy for disasters and safety. After discovering vulnerabilities in the disaster response system in the event of a catastrophe, Gimpo City created Gimpo Big Data Co., Ltd. As a public–private partnership corporation, Gimpo Big Data was expected to promote urban management efficiency by linking consumer-centered infrastructure systems with an open platform. A forum took place in which citizens could provide input about the quality of the aforementioned services.

Gimpo City Big Data Co., Ltd. held an inaugural general meeting in May 2015 based on an ordinance enacted in April 2015 and was formally established in June 2015. The equity structure of the organization was 20 percent, with that of other local industries comprising 80 percent. At the time of the establishment of the company, there were around ten staff members, including three researchers. As depicted in Figure 3, the strategies of the Gimpo smart city are to realize a safe and livable city with cutting-edge information and communication technologies, as follows:

- A clear vision and goals which are known to the public
- Public–private partnerships
- Communication and cooperation with citizens
- Sharing of information
- Standardization and globalization

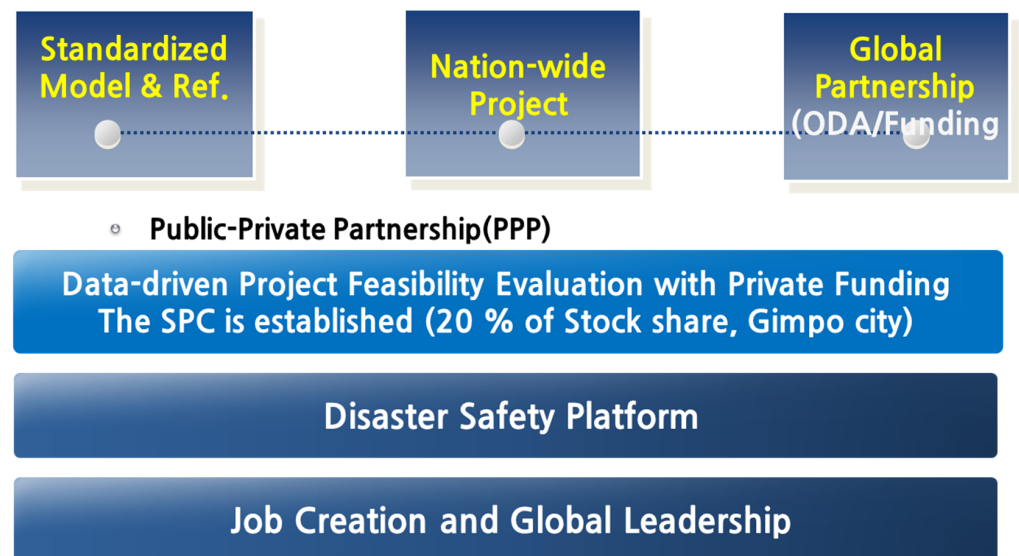


Figure 3. Strategies of Gimpo smart city platform (source: Gimpo).

4.1.4. Policy Implications

The case of Smartopia Gimpo reflects a sustainable smart city with a clear goal of improving disaster and safety management. It planned to construct, operate, expand, and innovate the platform infrastructure. Gimpo City jointly invested with the private sector to build an ICT-based administrative service platform and established a company that distributed big data. Since the platform service was not designed to generate profit, a business model was adopted to supply the private sector services by receiving a subsidy project from the central government. In other words, the producer of services is Gimpo Big Data Co., Ltd., (Gimpo, Korea) the consumer is the private sector, and the central government pays for the goods.

Challenges in the case of Gimpo were encountered in the unclear relationships among city government, City Council, vendors, and citizens, with these blurred relations eventually limiting stakeholder involvement. As stakeholder involvement is key to achieving a comprehensive understanding of smart city projects [18], narrowing the gap between the smart city initiatives and stakeholder expectations is critical to the successful implementation of smart city strategies [43]. The Gimpo Big Data Corporation broke up when a new Mayor took office in 2018. Local media and newspapers criticized the demise of the corporation during the project implementation process, while conflicts among the project director, the Mayor, and expert groups never clarified the business agenda. Its services to collect and use big data were also limited in terms of generating sufficient profit from the private sector due to personal information protection restrictions.

This case also implies that successful smart governance requires leadership on the part of the Mayor, citizen participation, and data-driven urban government operations. Effective smart city governance should strengthen social participation and inclusion to distribute the benefits of new technology to all members of society, reduce the digital divide, and overcome technologically deterministic risks.

4.2. Namyangju 4.0 Innovation

4.2.1. More on the Motivation Behind Smart Cities

NYJ has incorporated four smart city platforms in its operation to improve the effectiveness, impact, and responsiveness of its services to citizens, as presented in Figure 4: Big data analytics, IoT, citizen participation, and Smartwork Navigation. The city has developed and implemented various innovative practices into the four platforms. The city used big data analytics to improve its traffic flow (e.g., bus routes, bus schedules), predict and prevent the spread of seasonal infectious diseases, analyze the levels of citizen satisfaction

in order to assess service quality, and identify areas of potential improvement. The city's IoT platform is used to detect medical emergencies among elderly people living alone, automate farm systems, and monitor water and sewer levels while assessing water quality in real-time. Drones are used for public safety and fire prevention purposes.

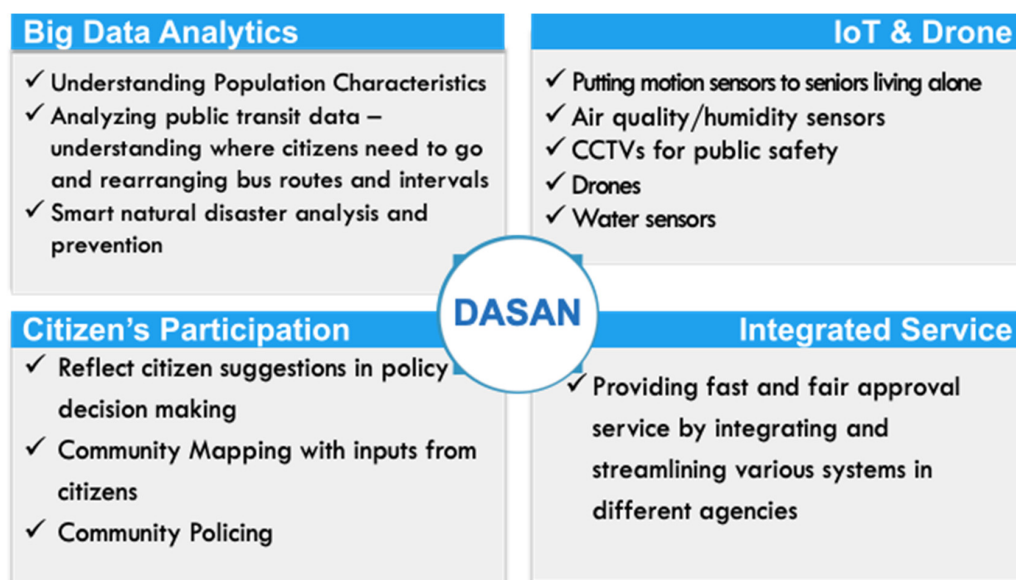


Figure 4. Analytic System Advancing Namyangju (DASAN) 4.0 Innovation (source: Namgyangju).

The third component of the active citizen participation platform provides access to an online community map that allows its citizens to share and view useful information about the city, so that citizens can directly present their opinions and suggestions regarding public policy to the Mayor and city administrators. Lastly, the City's Smartwork Navigation platform is designed to reduce intragovernmental barriers by connecting and integrating various systems in different agencies. Named *Namyangju 4.0*, the project had a budget of 15.5 million USD. The project period was set between 2017–2020, corresponding to the Mayor's second term.

Gimpo Smartopia focused on functional innovations in crime prevention, traffic alleviation, environmental preservation, and disaster management. In contrast, NYJ 4.0 focused more on internal process innovations in data-based policy decision-making to change how the government understands and solves policy problems. This was reflected in the 30 smart city project functional areas covering a wide range of administrative issues. At the time of data collection on NYJ in 2018, the city had implemented the first 14 smart city projects, including bus routing, traffic, crime, childcare, parking, automobile tax, sanitation, citizen leisure, the allocation of brick-and-mortar service centers, and others. While Gimpo Smartopia emphasized the creation of robust IT infrastructures and hardware, NYJ 4.0 focused on establishing innovative decision-making practices through relevant data collection and data analysis. The Mayor of NYJ was a proponent of data-driven policymaking and the primary driver behind NYJ 4.0. The Mayor made clear the two main goals of NYJ 4.0: increasing citizen convenience and enhancing administrative effectiveness and efficiency. The method of achieving these goals was data-driven policy decision-making.

4.2.2. Building a Process: NYJ 4.0 "Smart Cycle"

NYJ had completed 14 smart government projects in 2018. The functional areas of NYJ 4.0 projects cover a wide range of subjects, unlike those of Gimpo. The platform established as part of NYJ 4.0 was not a sophisticated control center equipped with IoTs and surveillance systems, but rather, it collected and analyzed data to identify policy problems and formulate solutions. Known as a 'Smart Cycle', this new practice may be characterized by the following steps:

1. Collect relevant data from NYJ or other governmental and nongovernmental sources;
2. Analyze the data to understand the nature of the policy problem or the issue to resolve;
3. Administer an initial solution and collect data on its impact;
4. Analyze the feedback data and revise and re-administer the solution.

In our interview with the Mayor, he explained his vision of the Smart Cycle as follows:

“I wanted to create a data-centered public administration. NYJ will make decisions after looking at the relevant data. When we need to explain ourselves to the citizens, we will quote the data on our decisions. Data shows us the way. Looking at the data shows us what, where, and how much the problem is and shows how to solve it. For this kind of public administration, securing relevant datasets and changing NYJ officials’ mindset are the most critical tasks.”

As a first step in smart cycle practice, NYJ began to explore its residents’ characteristics by analyzing existing or newly acquired data from other government agencies. This helped NYJ to understand residents’ characteristics and needs in detail. The data analysis provided valuable information about where the new residents of NYJ came from, where they worked, when they commuted, which modes of transportation they used, whether they were homeowners (with the amount of debt) or tenants (with the amount of rent), whether they had children, whether they were retired, and so on. Also, applying GIS tools helped NYJ to determine geographical concentrations of populations with similar interests or other features in common.

This enhanced understanding of the characteristics of residents led to the creation of projects that improved citizen convenience and the City’s administrative efficiency and effectiveness. For example, NYJ analyzed daily commute data using bus cards to identify commute patterns. It then worked with the bus companies to reroute and adjust the frequency of services. This dramatically cut commute times for residents who travelled to Seoul for work in the morning and returned home in the evening. In analyzing the data obtained from National Pension Service, NYJ first identified targeted areas where the most retired residents lived. The city then provided educational programs (e.g., programs on financial management, banking, health/fitness) in other neighborhoods, where fewer retired citizens were present. The program participants appreciated these programs and commended the accuracy of the data collected for analyses of their living concentration.

NYJ’s Smart Cycle process was applied in other city administration areas such as pest control, flood disaster management, elderly care, childcare, parking violations, automobile taxes, and public utility management. Using call center data regarding complaints about mosquitos and pest control requests during the summer, NYJ identified locations where pesticides should be sprayed. Also, using IoT devices installed by pest control vendors, NYJ monitored the impact of these measures on mosquito activities and adjusted its pest control decisions based on the collected data. NYJ located cars with tax delinquency for whose license plates would be subsequently removed by cross-tabulating parking violation data with automobile tax delinquency data.

NYJ’s 4.0 project was an internal innovation that established the practices of the Smart Cycle in administrative decision-making processes. It served as the engine for innovations in NYJ, and led to the completion of 30 projects that improved citizen convenience and administrative efficiency and effectiveness through data collection and analysis. While it is hard to quantify the level of convenience created by its smart city projects, NYJ estimates it saved approximately \$188,000 within two years.

4.2.3. Operations and Strategies

The operation side of NYJ 4.0 was spearheaded by a Big Data task force headed by the vice mayor, a Big Data expert hired from outside NYJ and NYJ officials. The task force identified and led 30 smart city projects between 2017 and 2020. Additionally, 20 teams composed of citizens, professors, experts, and government officials (374 individuals) were organized to function as advisory groups for smart city projects. While the Big Data

taskforce functioned as the core driver behind the NYJ 4.0 projects, another critical driver was the new culture of data-driven innovation that became the norm in the city government.

This cultural change took place through extensive training, workshops, and seminars at NYJ. NYJ had held 35 lectures and workshops presented by outside speakers on computer coding, blockchains, Big Data, and other innovations throughout 2018; 3263 public officers participated. Additionally, 45 internal workshops and sessions on coding and application training were offered to 676 employees. As a result, each NYJ employee attended, on average one workshop and training session. This series of educational opportunities brought about a significant change in the organizational culture by overcoming the inertia behavior of NYJ employees, a typical barrier to the implementation of smart city projects [44]. NYJ reflected the level of contribution by NYJ officials in the form of promotions and monetary rewards, which accelerated cultural change. NYJ's three-pronged approach contributed to transforming the organizational norms and culture; the three approaches were strong leadership vision and push, the formation of a Big Data taskforce and 30 smart city projects, and extensive training and education opportunities for public employees.

4.2.4. Policy Implications

The case of NYJ 4.0 Innovation illustrates how fostering a culture of innovation within a governmental structure can bring about convenience to citizens and improve administrative efficiency and effectiveness. Rather than focusing on building high-end hardware and ICT infrastructures, NYJ focused on obtaining and analyzing relevant data to understand the nature of policy problems and devise solutions accordingly. Its approach has some interesting policy implications.

First, NYJ's approach shows the potential for the creation of smart city projects on a relatively modest budget. Its focus on data collection and analysis does not necessarily require significant budgetary investment in the form of expensive hardware and equipment. During the interview with the Mayor, he stated that a data-driven administration is critical for local governments that do not have high budgetary capacities. This approach does not require much money, but it requires conscious and active efforts on the part of officials to collect and obtain the relevant data which, in turn, requires a change in employees' mindsets.

Second, the extensive training and education of NYJ employees and the subsequent impact of this on the NYJ culture would have an enduring effect on the way the NYJ administration would run. If it had been a top-down directive coming from the Mayor, the smart cycle could end once his term was over. However, the cultural shift that took place through workshops and training ensured the continuity of smart innovations in NYJ. NYJ's smart cycle practices have continued in various respects under the direction of the "Department of Smart City" that comprises four teams: an intelligent city team, a big data team, a city statistics team, and a smart city integration center team.

5. Discussion

Smart governance is a highly intelligent system that redesigns existing administrative practices and procedures with clear goals and collaborative leadership in conjunction with smart technologies and social networking [45]. It empowers governments and businesses, citizens, and local communities to share knowledge and data based upon a cooperative partnership through mutual transactions. A multistakeholder partnership needs a high degree of stakeholder involvement to prevent misunderstandings and divergent expectations among stakeholders [18].

This study demonstrated two approaches to smart city innovations. Smartopia Gimpo represents a top-down, infrastructure-focused smart city innovation that invested in the creation of a state-of-the-art, big data city control system consisting of an intelligent CCTV system, IoTs, and multi-image analysis solutions that can function as a real-time big data service platform. The city invested 40 million USD in the construction of physical infrastructure and established a public-private partnership platform, i.e., the Gimpo Big Data Co., Ltd., (Gimpo, Korea) to encourage citizen participation. This approach dramatically

improved the city's data management and surveillance capabilities for crime prevention and accidents and disaster mitigation. However, the project focus on hardware without establishing a culture of innovation inside the Gimpo bureaucracy was not sufficient for the creation of a lasting organizational transformation, especially after the mayor's departure. Smart city innovations did not continue after the leadership shift, and the city moved in a different direction under new leadership.

NYJ 4.0 was also top-down initiated by the Mayor, but its focus on extensive employee training and education regarding the concept and application of Big Data analytics, and its emphasis on data-driven decision-making, led to a culture of innovation that positively affected a wide range of NYJ businesses. NYJ's focus on collecting and obtaining relevant data within and outside NYJ agencies, and searching for ways to improve service quality, resulted in the creation of 30+ projects between 2017–2020 with less than half of the budget (15.5 million USD) used at Gimpo. The NYJ Mayor demonstrated strong leadership by encouraging NYJ employees to engage in data-driven decision-making for all NYJ businesses. The Mayor made it standard practice at NYJ to show results of its innovation projects with supporting data around two primary objectives: the degree by which convenience for citizens had increased, and the degree by which the efficiency of NYJ bureaucracy had increased. Additionally, NYJ's Big Data taskforce, headed by the vice mayor and a Big Data specialist, functioned as an innovation office providing consulting and technical support to NYJ departments and sections. Together, throughout the Mayor's term, the data-driven process of decision-making and innovation became a standard institutional culture that continued beyond the mayor's departure.

6. Conclusions

This case study has shown that smart city initiatives do not always equate to expensive and infrastructure-intensive projects. While Gimpo's infrastructure-driven smart city approach prioritizes the efficient operation in specific functional areas (e.g., traffic, crime, disasters), NYJ's approach emphasizes innovative organizational culture to lead a more holistic innovation in a broad policy areas. Similar to the Vienna smart city case [18], the high-tech infrastructure does not necessarily play a key role in implementing smart city strategies successfully, while it should maintain a certain level of quality to run smart city projects efficiently. The successful implementation of smart city projects for mid-sized cities entails sufficient investment in both human and social capital and infrastructure [3], leading to the sustainable development of innovation. In this approach, instilling a culture of innovation should be a critical part of smart city strategies to narrow the gap between participants, i.e., internal and external stakeholders or political leadership and government employees.

The cases of Gimpo and NYJ demonstrate and reaffirm the role of leadership to push smart city innovation. Leadership matters, not only in establishing the necessary technological and data infrastructure and hardware, but also in creating an institutional culture of innovation. A leadership push for innovation has a greater and more lasting impact when there is a corresponding culture of innovation at the organizational level. Facilitating a culture of innovation is not easy; it is often met with resistance [3,44]. However, we believe that thorough training of government managers and frontline workers could serve as a catalyst for a cultural shift within the government bureaucracy sector, giving rise to smart city transformations that can survive leadership changes.

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