INNOVATING INTER-GOVERNMENTAL COLLABORATION FOR SMART EMERGENCY RESPONSE SYSTEM : DAEJEON SMART CITY OPERATION CENTER, 2010 - 2017

By

KIM, Hyelim

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF DEVELOPMENT POLICY

2020

INNOVATING INTER-GOVERNMENTAL COLLABORATION FOR SMART EMERGENCY RESPONSE SYSTEM : DAEJEON SMART CITY OPERATION CENTER, 2010 - 2017

By

KIM, Hyelim

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF DEVELOPMENT POLICY

2020

Professor Lee, Junesoo

INNOVATING INTER-GOVERNMENTAL COLLABORATION FOR SMART EMERGENCY RESPONSE SYSTEM : DAEJEON SMART CITY OPERATION CENTER, 2010 - 2017

By

KIM, Hyelim

CAPSTONE PROJECT

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF DEVELOPMENT POLICY

Committee in charge:

Professor Lee, Junesoo, Supervisor

Professor Joo,Yu Min

Approval as of May, 2020

ABSTRACT

"Help me! Save me! Please!" Imagine that you witness an urgent situation and call 119, the emergency call number in the Republic of Korea (hereafter "Korea"). What if the emergency services team arrived on-site within six minutes, already recognized the situation and immediately began taking action?

Daejeon, Korea's fifth-largest city, successfully improved the quality and efficiency of its urban public services with a smart solution. Daejeon was the first city in Korea to integrate Information and Communications Technology (hereafter "ICT") infrastructure such as municipal networks and Closed-Circuit Televisions (hereafter "CCTV") at the metropolitan level. By 2013, Daejeon opened the Daejeon Smart City Operation Center, persuading relevant agencies on the need for equity in urban services and sustainably operating ICT devices. The relevant institutes combined their budgets and 10 departments with similar responsibilities from different organizations joined the center. Soon after, the Ministry of Land, Infrastructure, and Transport (hereafter "MOLIT") selected Daejeon as its research and development pilot smart city in 2014. The Daejeon local government and the national government worked together to introduce and customize the integration platform that connected five safety services for citizens. This collaborative work filled the gap of local government's lack of authority or financial capacity to accomplish its smart city goals with technical, financial, and institutional support from the national government.

From 2015 to 2017, the average response time for 119 emergencies in Daejeon decreased from about seven and a half minutes to less than six minutes. The city's crime decreased by about

1

5% and the arrest rate increased by about 7.7% over the same period. As of 2019, 49 local governments in Korea had adopted Daejeon's "smart city" model.

TABLE OF CONTENTS

LIST OF FIGURES

I. Introduction

A number of key smart city pilot projects in Korea have taken place in Daejeon, the fifth largest city in the country with a population of 1.5 million. Daejeon is undoubtedly not a globally well-known city, yet it is one of Korea's frontrunner in developing and implementing smart city solutions, together with the country's more notable cities such as Seoul (the capital city), Busan (the second largest city), and Sejong (the new administrative capital). How did the local government of Daejeon—neither a megacity nor a capital city—successfully complete its smart city projects that are costly and require extensive coordination and collaboration among different departments and government institutions? In particular, its notable development of metropolitan-wide smart emergency response system has become a smart city model to other 49 local governments in Korea. What was its development process, and what policy lessons can be learned from the experience?

There are two key motivations behind the development of smart emergency response system in Daejeon. The first motivation has to do with the fact that, in Korea, Daejeon is recognized as a city of science and technology. It is home to the Daedeok Research Complex, where about 15% of the Korean research and development funds are invested in 19 universities, 30 government-funded research institutes, and 400 affiliated research corporations (KTIPA, 2019). Daejeon developed and launched the Intelligent Transport System (ITS) with MOLIT in 2002. It also demonstrated various projects for the newest ICT such as the 3D spatial information system of the whole Daejeon area in 2007, the operation system of the public bicycle for the citizens in 2009, and the monitoring system for the construction site in the downtown area in 2019 together with the Korea Electronics and Telecommunications Research Institute located in Daedeok Research Complex. Given the city's reputation of being at the forefront of research and innovation, Daejeon wanted to develop

its image as a "smart city" in order to bring more attention to the research institutes and companies in Daedeok Research Complex and to enhance the city's competitiveness, while also solving urban problems.

The second motivation—reacting to the increasing crime rate and the city's difficulties in responding to emergency cases—explains specifically why smart emergency response system was developed, over others, as the key smart-city project in Daejeon. From 1996 to 2008, crime cases in the city increased from 32 thousand cases to 53 thousand cases and emergency medical services related to fires or accidents increased from 19 thousand cases to 54 thousand cases, and first aid and rescue activities increased from 3 thousand cases to 7 thousand cases. In addition, the reported incidents related to natural disasters such as floods and landslides increased from 175 cases to 7 thousand cases over the same period (Figure 1) (Daejeon , 2000 & 2010).

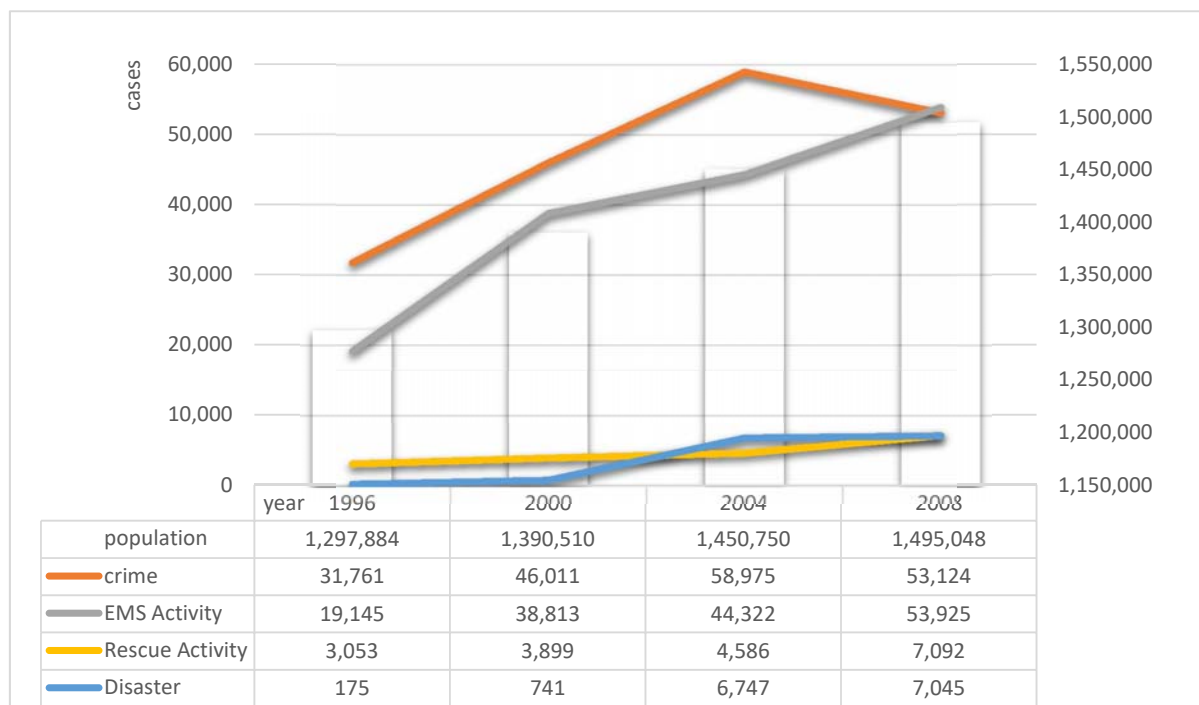| year	1996	2000	2004	2008
population	1,297,884	1,390,510	1,450,750	1,495,048
crime	31,761	46,011	58,975	53,124
EMS Activity	19,145	38,813	44,322	53,925
Rescue Activity	3,053	3,899	4,586	7,092
Disaster	175	741	6,747	7,045

Figure 1. Soaring demand for the city's safety (1996 - 2008)　　　Source: *Daejeon City Hall (2000, 2010).*

In addition to the growing demand for urban safety services, there were also a number of major challenges in the side of service provision. Police attending crime scenes often arrived after criminals had escaped to the city's underdeveloped areas or rather crowded downtown. Fire engines, ambulances, and police cars sometimes could not even find the location where an emergency had been reported. Ji, Ponghyeon, a deputy director of the Urban Economy Division at MOLIT, said most people calling emergency services were unable to accurately describe the scene, partly because they were calling from unfamiliar locations, and partly because of the difficulty people had providing clear descriptions in the face of an emergency[1]. Hence, in order to improve the safety of the city, Daejeon needed a solution that would enable emergency services to be more efficient and effective. Any solution would require enhancing cooperation between the police, firefighters, ambulances, City Hall, and five district offices which are the lower administrative units that make up the city.

The development of the smart emergency response system in Daejeon first started with its CCTV center development, which requires a brief explanation of the Doan New Town development, launched by Daejeon City Hall in 2008. The plan for the new town initially included a CCTV control center that was to collect and provide video information for accident prevention and emergency response specifically for the Doan area. The new town CCTV center construction began in July 2010, but soon after, the construction company responsible for building the new town faced a liquidity crisis and stopped the construction work for nine months. Daejeon City Hall attempted to save the plan by revising the project design and adding more funding through hundreds negotiations of the working group council. The decision group council also held six meetings to make decisions officially. Further, as the city finances were put into the project, the

---

[1] Author interview with Ji, Ponghyeon, Sejong, September 11, 2019

beneficiaries of the project expanded to the whole citizens, not just for residents in the new town. As a result, CCTV control center was redesigned for the entire Daejeon metropolitan city and was expected to serve as a stepping stone for the city's journey towards becoming a smart city.

However, in addition to the physical development of the center, which was completed in 2013, Daejeon needed to have a platform to operate the center and to develop linkage services for emergencies. This task was challenging, as Daejeon faced limited finance and regulation barriers that required institutional cooperations. At the time, coincidently, MOLIT already had developed smart city platform and was looking for a test site. Daejeon was selected as the pilot city for the platform in 2014 and began its collaborative work with MOLIT (Figure 2).

Figure 2. Cooperation and Collaboration

This paper examines how the Daejeon's smart emergency response system was developed. Through examining the developing process, the paper also explains the cooperation between different departments in the local government and collaboration at different levels of government which was fundamental criteria for building such integrate smart city solution. Especially, given the context of decentralization in Korea[2] and the strong national government in the administrative

---

[2] Korea asserted to decentralize in the mid-1990s. However, the faced financial lack of many of local governments has been below 50% of the self-reliance ratio of local finance, an indicator of how much local government was raising

system[3], it still had a hands-on many of the regulations and the financial resources needed to be addressed when developing the local smart city's solution. Hence it becomes imperative to know how the local government collaborates with the national government in what ways to produce this local smart city solution for Daejeon.

II. Literature Review

The concept of a smart city is flexibly adopted and used according to its object and situation. Countries, cities, scholars, and companies are flexibly using the definition of a smart city according to the level of economic development and the situation, establishing an individual smart city strategy tailored to each situation. (ITU, 2014; Angelidou, 2015; Glasmeier & Christopherson, 2015; Glasmeier & Nebiolo, 2016; Gaffney & Robertson, 2018; MOLIT, n.d.).

The main point of smart cities is the adoption and use of new ICT for urban management. McKinsey Global Institute (2018) describes smart cities as cities to respond quickly with low-cost to events and demand changes through more comprehensive real-time data and digital technology. It is to make improved decisions and progress in the quality of life. International Telecommunication Union (ITU) (2014) defines that the smart sustainable city is an innovative city that uses ICT to improve the quality of life, the efficiency of city operations and services, and to be competitive. Similar to the ITU, Korea's Smart Cities Act, which has been in effect since March 2018, defines smart cities as urban models that can solve various urban problems and create

---

its own funds for financial activities, except for Seoul. For more details on the self-reliance ratio of local finance in Korea, see KOSIS (2019).

[3] All police agencies in Korea belong to the national government and use a strong closed network and security system themselves. Before Daejeon launched the integrated working system through the Daejeon Smart City Operation Center, any government institutes could not connect the police network.

sustainable cities by incorporating new technologies such as ICT and big data into cities. In other words, smart cities solve urban problems and enhance the efficiency of public affairs by connecting key technologies of the Fourth Industrial Revolution (ICT, Big Data, etc.) with traffic, safety, energy, and other urban infrastructures (MOLIT, n. d.).

This study focuses on MOLIT's approach to the definition of smart cities. "smart cities" use ICT to improve the efficiency of city management and the quality of public services.

Smart cities are possible to make better performance by linking urban public services, such as traffic, crime prevention, disaster prevention, protection of the elderly, and fire protection, to the smart city integration platform operated by the city government. Big data collected in real-time from anywhere in the city can improve the quality of public services by rapidly analyzing situations and efficiently allocating resources. In particular, cooperation services among several institutions using this integrated platform are very effective in emergency situations involving security, arson, and disaster prevention and management (MOLIT, 2019). The United States, along with private companies, is trying to make the emergency management systems intelligent, safe and effective using advanced technologies. Specifically, in emergency management, Artificial Intelligence (AI) can predict, evaluate, and simulate incidents to simplify response time and response processes. In addition, the Internet of Things (IoT) technology enables the real-time data collection of the physical environment for disasters or emergencies and delivers the data to other departments quickly. That would help city governments and related agencies to make important decisions about emergencies more swiftly and accurately (Nancy, 2018). As such, in order to increase the citizens' satisfaction and government efficiency, the city integrates various public services and cooperates with relevant agencies and departments instantly and organically in an emergency situation. Meijer

& Thaens (2016), argue that the spread of technologies brings more influential values and motivations for collaboration.

However, cooperation is not always smooth. Diverse stakeholders face a variety of conflicts in a new environment without existing models, manuals, or precedents and repeating conflicts among stakeholders could threaten the completion of the task (Zuzul, 2019). Notaly, in cooperation with public or semi-public utility companies and local governments, stakeholders suffer difficulties because they work for different goals such as business profit for the companies and citizens welfare for the local governments (Neumann et al., 2020). Broccardo et al. (2019), point out that collaborative governance with diverse stakeholders is a useful tool for smart cities, but it could exacerbate the confusion, so authors insist providing clear assignment of roles and responsibilities for each stakeholder, standards and incentive schemes for performance measurement, and rational decision-making process would be required to success the collaborative works.

III. Delivery Challenges

3.1 Coordination and Engagement

The development of smart city operation system required the Daejeon to integrate dispersed infrastructure and services of its existing operating system. At the time, Daejeon's CCTV infrastructure was highly fragmented and there was little cooperation between government departments. For example, the garbage management department in the district offices installed and operated surveillance cameras to catch illegal dumping, the traffic management department in City Hall operated cameras to detect illegal parking, and each elementary school managed their own CCTV systems for students' safety. The installation cost of one CCTV was about 20 million Korean won (US$ 17,000) on average, and the maintenance and control costs for each individual system was a vast amount of money. There had been no effort to share costs across the different systems and economize on their budgets.

To incorporate these systems and implement a combined CCTV system Daejeon City Hall faced the challenge of coordination and engagement among a wide range of government offices and agencies. It had to persuade its five district offices, the Police Agency, the Fire Headquarters, the Office of Education, and the construction company to make integration of ICT infrastructures and the establishment of a smart city operation center at the metropolitan level.

After the physical infrastructures for smart cities were established, to operate the center Daejeon needed a platform, a hub in virtual space where data generated by CCTVs installed pervasively in the city are gathered and several related institutions can access and use the data to provide urban services. At that time of ahead of completion for building the center, luckily, MOLIT was recruiting cities to pilot the platform as an open competition. The Ministry invested 10 billion

Korean Won (US$ 8.4 million) to develop the platform from 2009 to 2013. Daejeon City applied for the competition and obtained the pilot rights. In the process of cooperation between local and national governments, Daejeon again faced challenges of coordination and engagement.

3.2 Regulations

Korea is one of the countries with the most robust privacy laws (Kwon, 2018). Under the privacy law, public agencies collect personal information but are legally restricted from sharing this information with other institutes. Image information generated by public CCTVs is also part of personal information. Under this law, a citizen could ask and verify personal information him or herself, but not others. When stakeholders ask for others' information, they have to request a police investigation officially and to take complicated steps to get the information they need. Therefore, Daejeon local government could not enable sharing CCTV image information among relevant institutes efficiently.

In Korea, the national government control security-related issues. Hence the police belongs to the national government, not affiliated with the local government, so the police agency has its own network and is highly secured. In order to establish a smart emergency response system for the safety of citizens, Daejeon had to connect with emergency service agencies such as fire and disaster centers, but above all, it was necessary to create a system for sharing information with the police in real-time. However, it was almost impossible that local governments request to make a direct connection to the police agency even it is located in Daejeon. The Daejeon local government needed institutional support from the national government to build smart emergency services. Despite challenges on the regulation and the linkage to the police, Daejeon City was solving these

by working with MOLIT as converged information and services are the core of the smart city. MOLIT made a cooperative agreement and memorandum of understanding (MOU) with relevant ministries and agencies at the national government level. Finally, Daejeon became the first local government in Korea to connect to the police network in 60 years.

3.3 Project Finance

As mentioned above, in 2010, the construction company building the Doan new town, a state-owned company under MOLIT, faced a liquidity crisis and suspended the construction of the new town for nine months. Although the company was making adjustments to cancel or reduce projects that were being invested or in progress in other cities due to poor financial conditions at the time. In November 2010, the company asked Daejeon City Hall to reconsider the new town plan on expenses and services. Accordingly, the councils decided to reduce the total financial scale from 38.4 billion Korean Won (US\$ 33 million) to 24.3 billion Korean Won (US\$ 21 million) for the whole new town project and to include 1.2 billion Korean Won (US\$ 1 million) from City Hall in the construction cost of the new town CCTV operation center in May 2011.

As the city finances were put into the project, the beneficiary targeting was extended to the entire city's residents from the residents who live in the Doan new town. Therefore, the physical scope was extended to the whole city area for the comprehensive urban management, and the services were selected and slimed according to the municipality's priority. As the plan was revised to be the integrated operation center, not only the construction cost of the operation center but also enormous financial expenses were needed to install and integrate expensive ICT equipment.

In addition, Daejeon's local finance was not enough to develop a platform and smart emergency response system. Daejeon had about 50% the self-reliance ratio of local finance, an indicator of how much local government was raising its own funds for financial activities (KOSIS, 2019). Luckily, However, Daejeon had a chance to get financial support of 1.25 billion Korean Won (US$ 1 million) from the national government at the time of finishing the construction and it made Daejeon go forward.

IV. Tracing the Implementation Process

4.1 Integrating ICT infrastructures into the Daejeon Smart City Operation Center (2010 ~ 2013)

In 2010, one of five district offices in Daejeon objected to the integrated operation of the CCTV center for the whole metropolitan city. This was because public organizations were very sensitive to the role and size of the organizations as it directly affected the promotion and power of the organizations. The police center in the same district, however, agreed on the consolidation and persuaded the district office to integrate. In addition, City Hall took the lead to the integration and persuaded the stakeholders individually.

There are three persuasive points of integrated CCTV center and other ICT infrastructures.

The first persuasive point for the integration at the metropolitan level was the equity issue of public service. In 2010, when Daejeon City Hall officials visited the latest built new town in Hwaseong city, which was similar in context to the Doan new town project, as a precedent

investigation, they found that the newly established CCTV control center was for only a small area and several officials were dispatched to this center from Hwaseong City Hall. It could be the problem of inequality of public service because the city government's finance and workforce was spent on the specific area not the whole city area. Focusing urban services on certain areas can cause problems such as rising property prices in those areas only. Through this case, Daejeon city officials convinced to insist on the integrated operation center at the metropolitan level because the city government should provide equal services to all citizens wherever they live in the city by establishing and operating an integrated CCTV center that can manage the entire city.

The possibility of sustainably operating the CCTV center was another persuasive point for redesigned the city's safety system. Daejeon is composed of five districts. If the CCTV control center is established by each district office for each district alone, the district offices have to install and manage their own networks, CCTVs, and other security equipment themselves. Moreover, they needed the storage spaces for fast-growing public data. It meant that five districts should have the financial and human capacity to install expensive ICT infrastructure and facilities and manage them. Each district, however, lacked such finance and manpower capacities. To manage the CCTV control center sustainably and efficiently, the need for an integration CCTV center for the whole city area, increased and stakeholders became accepting of it.

Another persuasive point was the needed spaces for the Data Center and the Traffic Control Center. Daejeon City Hall and its affiliated public institutions had operated Data Centers separately. There was an increasing need for the storage space of public data and improvement in cybersecurity was increased. Moreover, overlapped investments in similar infrastructure and services and the dispersed information as all institutions use individual networks and platforms caused inefficiency. To meet these needs, therefore, the Daejeon city government allocated a large

space on the second floor of the Daejeon Smart City Operation Center for the Data Center and the Cybersecurity Center. The Data Center was designed to integrate the network for City hall and five district offices and to take a charge of the cyber security for 240 institutes, including the City Hall, five district offices, public organizations, state-owned companies, and government-contributed research institutes in Daejeon. Because of the large scale of maintenance of storage devices, service platforms, and operating equipment, the center has systematically managed it at a low cost. This data management system has been assessed to have significantly increased the efficiency of the operation of public institutions.

At the same time, Daejeon City Hall had to find another place for the Traffic Control Center which had located in the former building of the Provincial Police Agency as the Provincial Police Agency moved from Daejeon to another city. Finally, the Traffic Control Center relocated to the second floor of the Daejeon Smart City Operation Center. This was because CCTV image data of the traffic control center can be used in connection with other safety-related services, as well as efficiently managing storage and operating equipment.

"The policymaking process for establishing the integrated smart city operation center took hundreds of times of discussions and negotiations. Finally, the integration was accomplished with great influence from civil servants' experience, precedent studies of other cities, and realistic conditions of Daejeon. ", said Choi, Dongkyu, a team manager of the Smart City Division in Daejeon City Hall.[4]

The Daejeon local government succeeded in integrating ICT infrastructure and the CCTV center for the entire Daejeon city area so that sustainable services was enabled while eliminating

---

[4] Author interview with Choi, Dongkyu, Ilsan, September 05, 2019.

service gaps between the existing city and the new town. To integrate the ICT infrastructures and construct the Daejeon Smart City Operation Center, combining the financial resources were required. At that time, the financial subsidy for safety for elementary school students from the central government made a timely appearance. In December 2010, the Ministry of the Interior and Safety had suggested making the CCTV control centers for districts and the Office of Education in the city and offered them 50% of financial support to construct each center. But, operating these expensive facilities was not sustainable and straightforward. Thus, the five districts applied for the financial support, and after that, they adjusted the use of the subsidy and combined the budget for the Daejeon Smart City Operation Center. As a result, the budget for building the Daejeon Smart City Operation Center has consisted of 55% from Daejeon City Hall, 33% from the construction company, and 12% from the Ministry of the Interior and Safety.

In October 2011, the budget for installing the cost of CCTV Control Center such as monitors and various equipment had been secured with 25% from Daejeon City Hall, 25% from the five districts and the remaining 50 % was from the Ministry of the Interior and Safety. And the Daejeon Office of Education took 50 % of the budget to establish the safety monitoring system for all elementary schools in Daejeon and the Ministry of the Interior and Safety took the remaining 50 % of it. Therefore, the issue of enforcing security for children was handled, installing eight CCTVs for each elementary school. There were 150 elementary schools in Daejeon at the time.

The City Hall took responsibility for the cost of the building maintenance and operating, and the five district offices and the Daejeon Office of Education covered the cost of monitoring and maintenance of CCTVs at the ratio of the number of installed CCTVs for each purpose.

In October 2011, the councils determined the redesigned project plan due to the financial crisis of the construction company and issues on fair and sustainable public services. The 16 different kinds of services in 6 sectors (traffic, environment, crime prevention, disaster prevention, culture, plan card, and health) originally planned for the new town area were slimmed down to 5 services in 2 sectors (traffic and security) for the whole city area. That was because the transportation and security services were the most urgent sectors among urban problems facing Daejeon City and were the services that citizens could easily experience and use. These were universal services for all citizens. In addition, Daejeon already was implementing the Intelligent Traffic Service (hereafter ITS) which was developed with MOLIT in 2002 and wanted to connect the traffic service with the newly developing area. Because without connectivity to the new area, the ITS would become less useful for the city as a whole. For a similar reason, security service was needed to be connected to the new town.

Building the center almost finished in 2013. However, officials had difficulties in the procedure of completion and permission for using because the various facilities in the Daejeon Smart City Operation Center belonged to each district office and divisions of City Hall as funding from various sources was spent on buildings and equipment. The possession of facilities was divided into the related departments in the City Hall and district Offices separately. Therefore, the officials involved had to go through complicated administrative procedures to get permission to utilize the center. The officials had to complete the inspection process and go through the acquisition process separately.

Besides, the construction contract was signed in 2008 along with the establishment of the councils at that time. It took five years to complete the construction of the center due to the extension of the construction period and the change of the project plan. As a result, when the

building was completed in 2013, the ICT equipment became too old. Especially server equipment had a short service life for about five years and rapid speed of technology innovation, became out-of-date during the construction period, even the manufacturing of some of the equipment had already been discontinued. The City Hall and district offices had difficulties in negotiating with the construction company to replace old version products with the latest products as much as possible. However, the construction company wanted more profit and less input even though it was a public enterprise affiliated MOLIT. Replacing some equipment meant the company had to invest more money. Hence only a few pieces of equipment were replaced with the newer ones, most of the obsolete equipment was accepted since the purchase contracts had already been in 2008.

Due to the extended duration of the project and the diversified stakeholders, there were many difficulties in completing the development. However, the relevant organizations and departments worked together to implement complicated procedures. Even though there were best efforts to change the out-of-date ICT equipment, City Hall and district offices ended up with obsolete equipment. In October 2013, the center was approved for use, and in December 2013, the center began pilot operation for three months and in March 2014, the center had its opening ceremony.

From 2014 to 2016, ten similar-function departments from different organizations, four departments in Daejeon City Hall, five district offices, and one department of the Daejeon Office of Education, have joined into the Daejeon Smart City Operation Center stage by stage.

At the first stage in March 2014, the Information Division of the City Hall moved to the Daejeon Smart City Operation Center and set up the Smart City Management Center on the first floor. Soon after, the CCTV Control Center, monitoring all CCTVs for security and illegal parking

for 24 hours including surveillance CCTVs around 150 elementary schools, was established by shifting staff from the five district offices and the Daejeon Office of Education (Figure 3). The CCTV control center was established not to control other departments but to support the moved departments in sharing the visual information in real-time for citizens' safety.

Figure 3. The CCTV Control Center at the second floor in the Daejeon Smart City Operation Center

Secondly, by June 2015, the Transportation Policy Division of the City Hall moved to the Daejeon Smart City Operation Center. And the division set up the Smart Traffic Information Center which controls all city on-site transport for 24 hours and takes charge of maintenance on transportation facilities. The Daejeon Police Agency dispatched six traffic monitoring police officers to the Smart Traffic Information Center to check the traffic flow and the situation of the whole city with traffic CCTVs. The traffic monitoring police officers adjusted traffic lights to ease traffic congestion and instructed the field traffic cops to check the on-site situation. They allowed

citizens to view traffic information about the traffic congestion section and spend time to go through it in real-time through the Variable Message Signs (VMS), installed on the main roads. Also, they delivered real-time traffic information through radio, smartphone applications, and web portal services and let citizens know where the bus was and when the bus arrived through the electronic bulletin boards installed at every bus station in Daejeon (Figure 4).

Figure 4. The multimedia of the Smart Traffic Information Center

Next, by November 2015, the Local Information and Cyber Security Center, which managed the data resources and defenced any kinds of cyber-attacks, was founded by shifting and integrating all ICT and computing equipment and devices of public institutes in Daejeon.

The staffs of the center was set with 75 persons in 2015, consisting of 9 officials from the City Hall, 15 officials from the district offices, 6 officials from the Daejeon Police Agency, and the 45 monitoring staff. And the workers were increased to 149 by the end of 2016, 33 officials were from the City Hall, 14 officials were from the district offices, 10 police officers, 53 monitoring staffs, 17 IT specialists from the contracted companies, etc.,

One monitoring staff had monitored 200 CCTVs with a double-shift work system in 2014, and it enlarged to 329 CCTVs per one staff in 2017 as the number of CCTVs were increased. To enhance the working efficiency, the monitoring staff were trained to focus on the screen that has

any activities ongoing. The City Hall took charge of the hiring, training, and management of the CCTVe monitoring staff.

Daejeon has expanded the number of public CCTVs rapidly. The installed CCTVs for security was 1,281 in 2010, 1,594 by increased 391 CCTVs in 2011, 1,985 by increased 333 CCTVs in 2012, 2,318 by increased 385 CCTVs in 2013, 2,703 by increased 215 CCTVs in 2014, 2,918 by increased 543 CCTVs in 2015, 3,461 by increased 827 CCTVs in 2016, and 4,288 CCTVs by increased 414 CCTVs in 2017 (Figure 5).
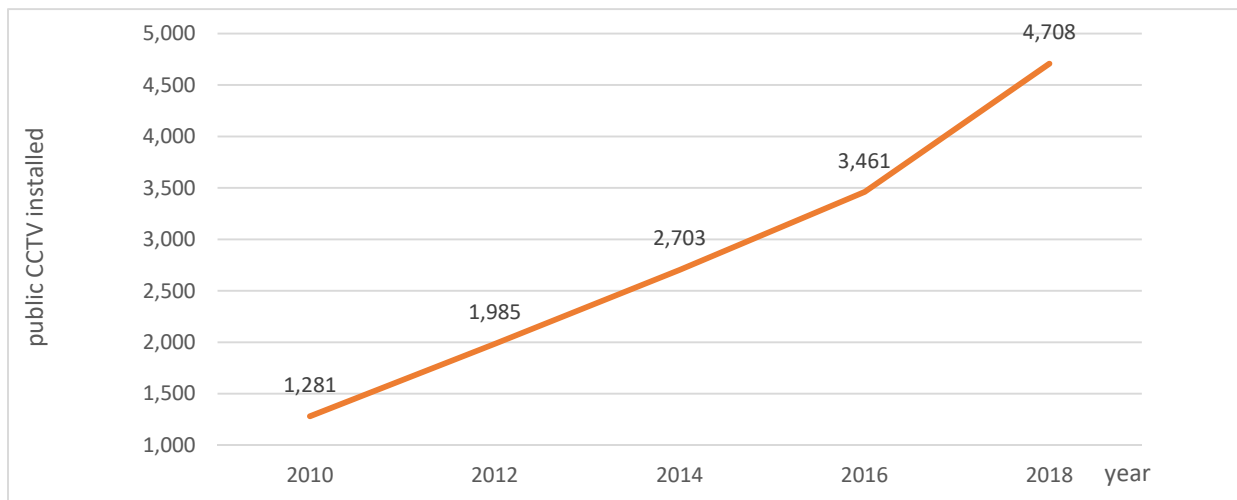

Figure 5.The number of Public Institute CCTV Installation in Daejeon   Source: *Daejeon City Hall (2019)*

This was because crimes and violence became more serious and brutal, citizens have been calling for more CCTVs coverage. Dr. Lee, Sanghun, a research fellow in the Smart City Research Center in Korea Land and Housing Institute, said that citizens are demanding increased security in public according to the rise of large-scale terrorist and horrible crimes all over the world.[5] According to the 2018 Social Indicators of Daejeon, 49. 8 % of Daejeon residents wanted more

---

[5] Author interview with Lee, Sanghun, Daejeon, September 09, 2019.

CCTV installations for improving city safety. And strengthening local police patrols (18.7 %), renovating street lamps (12.2 %), managing unoccupied houses (7.2 %), strengthening patrol volunteer activities (6.9 %), guardian system for children (5.9 %), and others (0.1 %) were followed for a more safe city.[6]

The installation of child safety CCTV was designated and managed by the city office of education, and the installation cost was distributed to the Ministry of Public Administration and Security and the Daejeon City Office of Education. In the case of security CCTV in districts, citizens applied for CCTV installation at the district office themselves when they felt any risks in the area where they lived or did business. Then the district office and local police station investigated and selected the appropriate location together. The police decided the location for new CCTVs by analyzing the data on the crime frequency and region. The administrative notice should make 20 days in advance to install a CCTV. Five districts each have added ten new CCTVs per month on average. The district office applied for costs to the national government and received a subsidy through deliberation. When there was a demand for surveillance CCTV from City Hall, the city discussed it with police and installed it with the city budget.

The building of Daejeon Smart City Operation Center was constructed, the installation of public CCTVs for security was increased significantly, the ICT equipment and the network were connected to the center, and four sub-centers were set up sequentially. Daejeon was thus equipped with hardware for a smart city.

---

[6] For more details on citizens' need for urban safety, see Daejeon (2019).

4.2 Cooperating with the Ministry of Land, Infrastructure, and Transport to make the Integration Platform and Developing the Smart Emergency Response System (2014 ~ 2015)

Daejeon had to develop an integration platform to collect and utilize data, control CCTVs, and operate the center. The Daejeon local government was selected as the MOLIT's smart city R&D pilot project in April 2014 as Daejeon needed to collaborate with the national government to get technical, financial, and institutional supports (Figure 6).
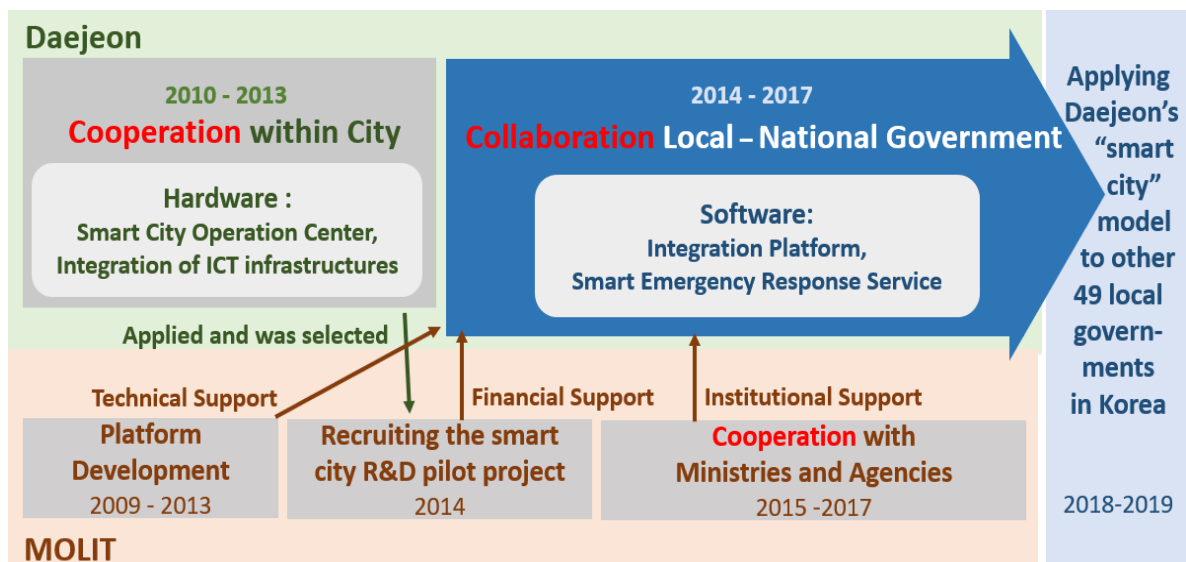

Figure 6. Collaboration between Local Government and National Government

Daejeon faced financial limitations and institutional barriers for sharing information among safety-related public agencies and coordinating with the national police. These difficulties were definitely beyond the authority of the Daejeon local government. MOLIT which had the same goal as Daejeon as a national government worked to make the way to share information and to connect others' networks. MOLIT made an effort to set the institutional environment for the smart emergency response system at the national level with persistent persuasion to relevant ministries

and agencies. The cooperation between the ministries was not easy from the beginning, but after the Sewol ferry incident[7] in 2014, they agreed to improve the emergency response system (MOLIT, 2019). This new system was designed to link national safety systems with local governments, police, firefighting, and disaster agencies from a single integration platform.

MOLIT and the National Police Agency made the MOU in July 2015. Before this official collaborative system, there were several complicated procedures to get the information needed to take action even in an emergency. That was because using personal information was a very cautious and sensitive matter and above all, it was strictly limited by laws. Based on this MOU, the Daejeon Smart City Operation Center were able to provide CCTV videos of the scene and the escape route of the criminals when 112 reports, the police call number in Korea, were made or emergency dispatches were in progress for cases involving kidnapping, robbery, assault, etc.,

Next, MOLIT and the Ministry of Public Safety and Security made the MOU in September 2015. In the case of fire, rescue, and other emergency situations, the Daejeon Smart City Operation Center could send the real-time videos of the fire scene and traffic information, etc. to firefighters to procure the prime time of the initial response.

The MOU between MOLIT and private communications companies was signed in July 2016. In the case of emergencies for children, patients suffering from dementia, and senior citizens living alone, the Daejeon Smart City Operation Center could receive their photos, location information, etc. from the companies to identify the location and situation with CCTVs and then takes the

---

[7] An incident in which 304 people, including 250 high school students on a field trip were killed in a disaster in April 2014, all Korean citizens were shocked about the non-working national disaster control system, it was discovered as a manmade disaster because of the high possibility of rescuing all the ferry's passengers. Consequently, after the Sewol ferry incident, MOLIT was striving to strengthen the general national disaster management system.

appropriate actions such as reporting that information to the police station or fire department. Before making this convergence system, the police used to use only the GPS coordinates of the reporter. However, children, patients suffering from dementia, and elders could not easily report themselves to emergency rescue services, and it led to regrettable situations sometimes.

Daejeon City Hall established a new division "Smart City Division" in January 2017 to operate the center given more autonomy and made an executive director position. The division has consisted of Geographic Information Team, Information Management Team, and Video Monitoring Team. This reorganization meant that the Daejeon local government's role regarding smart cities was newly created and expanded. This was also the city's will to maximize the city's capabilities by rearranging its organization and manpower in keeping with the tide of the day. Building the Smart City Division in Daejeon City Hall separately showed the willingness to develop a smart city as a city of science and technology and to strengthen the identity of Daejeon.

4.3 Test-operating and Upgrading the Cooperation Services (2016 ~ 2017)

Daejeon has developed and upgraded the services constantly in analyzing results of events. The city recognized the hit rate by analyzing the accuracy of providing CCTV images for incidents requested by the police or fire departments. The related institutes, therefore, compensated more CCTVs into the area which had low hit rates to enhance the accuracy. Daejeon also has gathered the feedback from the police and fire departments and tried to enhance the quality of the services and to reform the way how the information is sent to the relevant departments based on the feedback. Through continuous feedback and corrections, each agency enabled to respond to emergencies by exchanging information in real-time without complicated procedures.

Daejeon actualized the real-time cooperation services for emergencies for citizens' safety as the Smart Emergency Response System. That consisted of ① 119 Emergency dispatch service, ② 112 On-Site videos support service, ③ 112 Emergency Patrol Service, ④ Disaster Safety Respond Service, and ⑤ Support for children and the aged. The cooperation services have linked on the integration platform of the Daejeon Smart City Operation Center like figure 7.
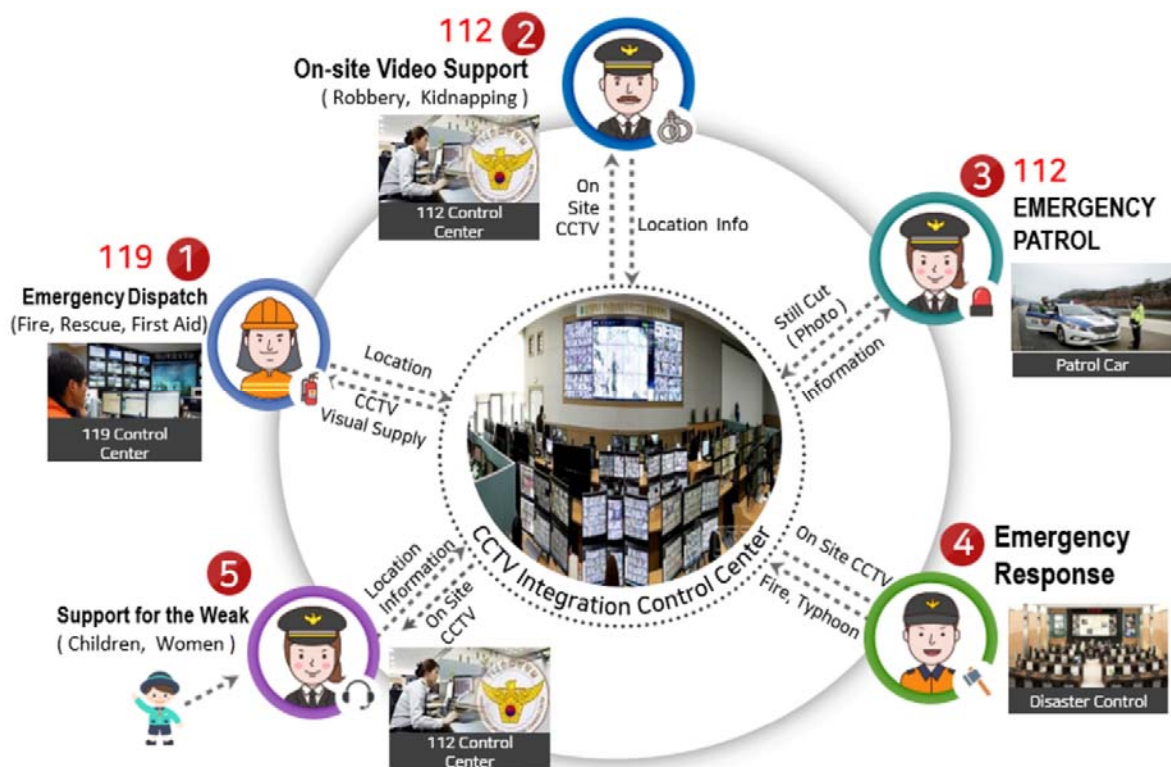

Figure 7. The Smart Emergency Response System

① 119 Emergency dispatch Service

The 119 Emergency Dispatch Service was to secure the golden hour for fire suppression and lifesaving by receiving real-time CCTV video and traffic communication information of the fire point from the Daejeon Smart City Operation Center. It was important to save even half minutes

for lifesaving as a person's life could be at the crossroads of life and death in one to two seconds in an emergency. This service was developed over 15 months from July 2015 to September 2016.

When the 119 Emergency Center received a call from the reporter, it simultaneously notified the Daejeon Smart City Operation Center of the situation. Then, the Daejeon Smart City Operation Center shared real-time CCTV images to the 119 control room and the 119 control room analyzes the type of fire and the condition on the field through the visual information. The 119 control room let the 119 dispatched vehicles figure out the situation and prepare the equipment that fits for the type of fire. Hence, when the dispatched vehicle arrived near the fire site, the field firefighter could have the execution strategy for fire out or rescue or first aid. Before implementing this convergence service, when a report came to the fire department, firefighters received the information the reporter described. This service has been most often used for the safety of citizens.

"After introducing the real-time cooperation service, firefighters working field could get more information on the site and type of fire. It helped to make the strategy to handle the emergency situation", said Part, Nojung, a team manager of the Gung Town 119 Safety Center.[8]

② 112 On-Site Videos Support Service

The Daejeon Smart City Operation Center supplied real-time CCTV images on the accident scene's surroundings to the 112 Control Center to take action rapidly in case of kidnapping, robbery, and violence. This service was developed over 24 months from July 2015 ~ June 2017.

---

[8] Author interview with Park, Nojung, Daejeon, February 18. 2020

When the police agency received a report, the officials generated the location information and appealed cooperation to the Daejeon Smart City Operation Center. Right after getting this request, the Daejeon Smart City Operation Center provided CCTV images and videos. 112 Control center grasped the emergent situation and ordered the nearest patrol cars or district police office from the field out. Before utilizing this service, the police officers had depended on only the verbal description form the reporter. It had a limitation and misunderstanding about the situation because the reporter could not explain the location and situation exactly in an urgent situation. After executing this *112 On-Site Videos Support Service*, however, the police agency recognize the field situation with the visual information provided by the Daejeon Smart City Operation Center and take action appropriately and rapidly.

③ 112 Emergency Patrol Service

The 112 Emergency Patrol Service was to provide real-time CCTV images on a wireless network for police officers and help to arrest criminals. The Daejeon Smart City Operation Center supported the police officers by providing the information and evidence of the route that the criminal used to get away. This service was designed over 30 months from July 2015 to December 2017.

When the 112 Control Center receives a report, the police officers identify the location of the reporter and order a patrol car to go on-site, and at the same time, they request for cooperation from the Daejeon Smart City Operation Center. The center checks the visual information around the location of incidence and supports the police officers in the patrol car by sharing the scene photo and evidence of the case. Through this service, the criminal arrest rate has increased, and the criminal cases have been dealt with promptly.

④ Disaster Safety Respond Service

The Disaster Safety Respond Service was developed over 14 months from October 2016 to December 2017. In the occasion of a large-scale disaster or a catastrophic hazard such as typhoons, heavy rain, mountain fires, the Daejeon Smart City Operation Center provides real-time CCTV images to the disaster safety situation room to identify the situation and recover from the damage quickly. In addition, the Daejeon Smart City Operation Center tried minimizing disaster damage by providing information such as disasters, accidents, and diseases to the citizens in real-time through road electronic signs and announcements. Disaster-related situations were reported to the national disaster management system in real-time. Before the service was introduced, some CCTV images were used in these situations, and oral or written reports had to be relied on. However, after the service was introduced, CCTVs across the country were used to quickly identify and take action. It also secured citizens' safety by spreading real-time information and news.

"When the river blew rapidly due to the heavy rains poured in August 2017, and the trails around the river and the underground roads were submerged. The disaster response headquarters identified dangerous areas based on the visual information from the Daejeon Smart City Operation Center and instructed the related organization to take measures for the safety of citizens. The police, rescue agency, district offices quickly blocked citizens accessing the designated areas and tried to

Figure 8. Natural Disaster Response Situation

minimize damages. The center informed citizens of the information on flooded roads through the ITS to minimize inconvenience.", described Lee, Youngmi, an officer in charge of the Smart Emergency Respond System in the Smart City Division in Daejeon City Hall (Figure 8).[9]

⑤ Protection services for children, the aged, and the disable

The protection services for children, the aged, and the disabled was developed over 14 months from October 2016 to December 2017. This service cooperated with Korean private telecommunications companies. In order to receive this service, citizens had to register personal information such as photographs, height, phone number, and special characteristics of children, dementia patients, disabled persons, etc., If a child or dementia patient got lost or faced an emergency situation, they pressed the button on the small device. And it triggers alarm bells of the guardian's mobile phone. The telecommunications company sends the protected person's location, photos, and contacts to the Daejeon Smart City Operation Center, and the center checks the neighboring CCTV images to identify the situation and requests emergency dispatch to the 112 or 119 centers. The Daejeon Smart City Operation Center and police officers and emergency rescue teams works together to rescue in real-time.

4.4 Communicating with Citizens

To show citizens how the government was using CCTV systems to make the city safer and to make experience smart city services for citizens, Daejeon set up a showroom on the second floor

---

[9] Author interview with Lee, Youngmi, Daejeon, September 09, 20819.

of the center. This showroom has also been used when officials from other cities and public institutes in Korea visit for precedent studies or when foreign officials come to receive training. The showroom has glass windows to look down into the CCTV control center room so that visitors could understand how the collected images from around the city and how image information was linked to other agencies to improve the safety of the city. In addition, there were virtual CCTVs installed and programs and equipment that could be operated and simulated directly by the visitors.

The showroom began with the opening ceremony of the center, and the number of visitors increased gradually, and by 2017, 4,077 people had visited the center and operated CCTVs in a hypothetical situation and experienced how the related agencies are connected and provide services organically. More than half of these visitors were students, and 576 were general citizens, including 136 foreign officials.

Dr. Lee, Sanghun, a research fellow in the Smart City Research Center in Korea Land and Housing Institute, stated that the showroom is not just for understanding and experiencing the center, but also for the effect of education. By watching and adjusting the CCTV themselves in the showroom, citizens become aware of the enhanced city safety system and watch out for their actions. The operation of this public relations halls is a stepping stone to increase the effectiveness of crime prevention and increase citizens' understanding and participation in smart cities.[10]

---

[10] Author interview with Lee, Sanghun, Daejeon, September 09, 2019.

4.5 Privacy Invasion Issue

The issue of privacy invasion is one thing that cannot be missed regarding CCTV installation and data collection.

As of 2019, no data from the Daejeon Smart City Operation Center had leaked. The monitoring employees in the Daejeon Smart City Operation Center must pledge to keep information related to their work confidential and not to release it. Also, all their belongings such as mobile phones should be stored in a locker before entering the center. This is because the daily lives of citizens are exposed through CCTV. In addition, these rules legally prevent the leakage of any personal information.

The national government also has considered privacy issues to design the smart emergency response system. The Ministry of Land, Infrastructure, and Transport proceeded with lawful advice whenever planning services related to the security system using CCTV. It made the assurance to design the security system and service such as image information provision, record, authentication, and network separation, etc. In detail, Korea's Act on the Construction of Smart Cities stipulates, the related costs for the provision of smart city services can be supported within the budget (Article 19-3 of the Korean Act). The Personal Information Protection Act allows third parties to access personal information when the risk of life, physical damage, preservation of property, and criminal investigations (Article 18-2 of the Korean Act). When a citizen makes a report regarding crime (homicide robbery, attack, detention, theft, kidnapping, sexual assault, and violence), fire, emergency rescue, and first aid, or when children and person suffering from dementia presses an emergency button, the police agency or the fire department, the agency has responsibility to serve, can access to the personal information. When the police or firefighting center notifies the Daejeon

Smart City Operation Center of the reporter's location information, XY coordinates from GPS tracking on the phone used by the reporter, the center immediately transmits the CCTV images around the reporter to the agency for real-time cooperation. When providing CCTV images, the local government checks the procedures and keeps records of the provision. Images provided must be destroyed when the purpose for which they were provided has been fulfilled. The use of CCTV information is possible only in a strictly limited range and situations, everything the camera sees is recorded, and video images are stored for 30 days and deleted automatically.

4.6 Outcomes

The number of public CCTVs in Daejeon increased from 1,281 in 2010 to 4,288 in 2017. All images and data from the CCTVs had been collected and shared through the integration platform at the Daejeon Smart City Operation Center. In 2017 alone, the Daejeon Smart City Operation Center provided visual information of CCTVs to support 8,779 cases of police dispatches, 5,758 cases of emergency, 438 cases of regarding disasters, and 142 cases of protection adults suffering from dementia, children, and missing persons.

Figure 9 shows that the Daejeon city's crime decreased by 2,610 cases from 2015 to 2017 (49,593 cases in 2015, 49,036 cases in 2016, and 46,983 cases in 2017). And the arrest rate, the ratio of the number of crime occurrences divided by the number of criminal arrests, increased by about 8% in the same period (80.5% in 2015, 86.3% in 2016, and 88.2% in 2017). In particular, the five major crimes, an indicator of the type of "five major crimes (murder, robbery, rape, violence, and theft)" frequently used by Korean police was introduced in the early 1990s and used until recently, in Daejeon was decreased by 3,205 cases (18,990 cases in 2015, 16,835 cases in

2016, and 15,785 cases in 2017). The arrest rate on the five major crimes increased by 11.6% (68.3% in 2015, 77.2% in 2016, and 79.9% in 2017). The average response time for 119 emergencies was shortened by 1 minute 28 seconds (7 minutes 26 seconds in 2015, 6 minutes and 30 seconds in 2016, and 5 minutes 58 seconds in 2017). The on-site arrival rate in 7 minutes, rose by 15.4 % (63.1% in 2015, 72.8% in 2016, and 78.5% in 2017).
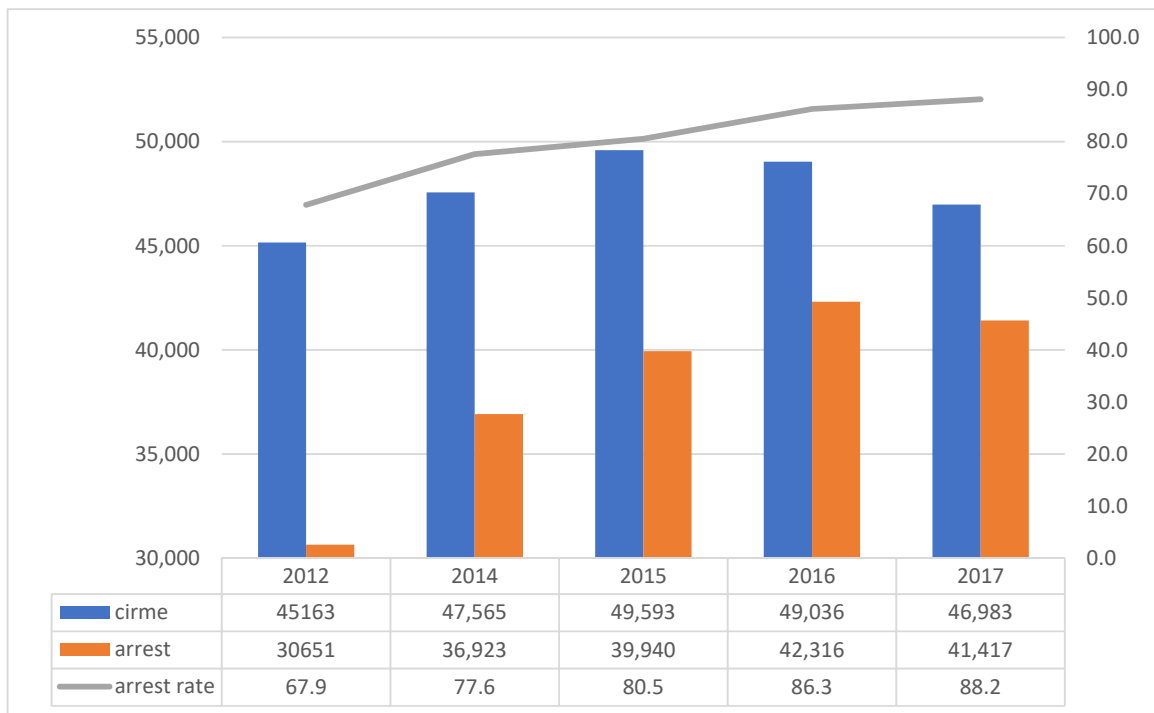

	2012	2014	2015	2016	2017
cirme	45163	47,565	49,593	49,036	46,983
arrest	30651	36,923	39,940	42,316	41,417
arrest rate	67.9	77.6	80.5	86.3	88.2

Figure 9.Crime and Arrest in Daejeon   *Source: Daejeon City Hall (2014, 2018).*

Not only public institutions but also the private sector can request CCTV video information according to the procedure. In 2017 for one year, individual citizens and companies made a total of 481 requests for CCTV images and data, of which 102 were released to them as these requests satisfied the requirements. Since the center retained the video data for 30 days, there were 270 nonexistent items and 49 and 60 cases were closed and canceled, respectively. On the second floor of the center, a public relations room was set up to promote the safe city for citizens, to help

3 6

cooperative work with public officials in related institutions, and to share know-how with visiting officials from Korea and foreign. In 2017, a total of 1,698 people visited the center and participated in the PR activities in 96 times. Daejeon's smart city model has now spread to 49 local governments across Korea by 2019, and the Ministry of Land, Infrastructure, and Transport is planning to implement this model in 108 local governments by 2021.

V. Lessons Learned

5.1 Holistic Design of Public Service for Various Urban Issues

Daejeon City designed a comprehensive solution for various city problems such as fire suppression, emergency rescue, arrest, protection of children and the old, and coping with natural disasters with a holistic frame of emergency services for civil safety. Beyond the previous working way of relying only on the citizen's phone report and dealing with the emergency situation individually, the developed smart emergency response system is more efficient and accurate with the improved quality and quantity of information using CCTVs and the real-time cooperation among relevant institutes. Local governments should consider the holistic approach for public services that can solve various problems on the whole with limited budgets and infrastructures rather than providing a separate solution in each organization's ways.

Besides, when Daejeon faced the challenges of data storage and cybersecurity for individual public institutions in the city, Daejeon designed an aggregated data center at the Daejeon Smart City Operation Center rather than responded to every unit of the organization. This holistic data management system decreased the cost of infrastructures and facilities, operation, maintenance,

and the workforce. Even further, due to the large scale of data, Daejeon could work with professional data management companies, and it obtained specialty improvement.

5.2 Universal Design of Public Service for Equity and Sustainability

City governments exist for the welfare of all citizens and operate from the taxes of citizens. Therefore, all citizens should be beneficiaries of public services, not specific regions or targets. Putting Fiscal and manpower from city governments for specific regions is not a justification for the equity of public services and the sustainability of operations. Daejeon integrated the ICT infrastructure as the metropolitan city unit and executed key services such as traffic and emergency response demanded from citizens instead of experimenting or demonstrating with various services using state-of-the-art technology in the Doan New Town. The city emphasized the equity of public services and the sustainability of operation, not focused on the short term outcomes of the pilot project. Hence Daejeon designed the smart solution for all citizens and made it universal public services. Therefore, there was no opposition from parliament or citizens at all due to the universal characteristic. It provided justifying extension to other public services reflected citizens' demands. The developed platform can handle 26 services at maximum and the city plans to enlarge the smart solution fields step by step.

"In Korea, there are no precedents for smart solutions expanded to city levels from the pilot project in the districts. In particular, Due to expensive smart city infrastructure, it is impossible to

3 8

achieve spatial expansion with the financial power of local governments.", said Choi, Dongkyu, a team manager of the Smart City Division in Daejeon City Hall.[11]

5.3 Connectivity and Flexibility for Smart City

Another point that Daejeon concentrated on for the smart city solution was the connectivity of existing urban service and infrastructure to new ones. The newly developing area in the city should be integrated to utilize information into existing urban management infrastructure and systems. Daejeon connected the newly developed Doan New Town with the Intelligent Traffic System that was being implemented in Daejeon and integrated the newly installed CCTVs in Doan New Town into the Daejeon Smart City Operation Center.

Flexibility is one of the important characteristics to build smart cities due to the rapid speed of technology development. The smart city projects should be designed flexibly to reflect the rapid trend change of ICT technology. When cities contract with the contractor, it is recommendable to make efforts for the contract with flexible conditions regarding technology. When Daejeon completed the construction and acquired the facilities, it was difficult to negotiate for replacing the devices and equipment outdated technology at the time of signing the contract with the facilities applied newest technology. Smart city projects should consider the flexibility of rapid technological change.

In terms of cost and quality of service, beyond replacing the product outdated technology with the product using the newest technology, cities need to flexibly integrate technologies to plan

---

[11] Author interview with Choi, Dongkyu, Daejeon, September 09, 2019.

smart cities. For example, a new smart city could combine CCTV and drones to obtain visual information more plentifully and quickly. As one CCTV can cover up to a radius of 50m, there are many blind spots between installed CCTVs as the devices are fixed. To compensate for this, Daejeon plans to install 26 drone stations in the City with the financial support from MOLIT from 2020. It is expected that drones will be able to cover a radius of 2 km from the station and to acquire more accurate and speedy field information within two minutes, it will speed up the smart emergency system. In terms of cost, this convergence is also efficient. There are about 5,000 CCTVs installed in Daejeon, which total input cost about 100 billion Korean won (US$ 85 million) but still have many blind spots. In the case of drones, however, the city prepared 26 stations for drones located in 119 safety centers. This plan needs about 3 billion Korean Won (US$ 1.8 million). Due to the large gap in cost for CCTVs and drones, when planning a new smart city, flexibility such as proper placement of CCTV and drones or convergence of various tech is required.

5.4 Collaboration beyond Cooperation: Synergic Work between Local and National Government

The dictionary meanings of collaboration and cooperation are similar. Cooperation, however, divides work into parts and then the person or organization in charge complete each part and later puts the parts together, while collaboration is the process by which several people or organizations work together at the same time to generate outcomes. In other words, collaboration is a synergic working style that can be done by gathering the abilities of many stakeholders that cannot be solved separately. It requires a complex coordination process by putting together each one's knowledge and wisdom to generates results.

Daejeon had to collaborate with MOLIT to accomplish the smart emergency response system. Collaboration beyond cooperation was needed. It was impossible to implement a smart city solution with the situation of 50% financial independence of local government. Above all, there was a clear limitation of the power of local government in the situation of Korea, in which the security agenda is controlled by the national government level. Nevertheless, Daejeon local government collaborated with the national government and went ahead to solve these issues together. Kim, Ingi, a deputy director of the Smart City Division, confirmed that the Daejeon city government needed financial, technical, and institutional supports from the central government.[12]

Since the smart emergency response system requires the establishment of a real-time cooperation system and access to information between relevant departments, institutional setting at the national government level was necessary. Collaboration between local government and the national government was one of the key points of the Daejeon smart city model.

---

[12] Author interview with Kim, Ingi, Daejeon, September 09, 2019.

References

Angelidou, M. (2015). Smart cities: A conjuncture of four forces. *Cities, 47*, 95-106

Broccardo, L., et al. (2019). Smart city governance: exploring the institutional work of multiple actors towards collaboration. *International Journal of Public Sector Management, 32*(4), 367-387.

Daejeon City Hall. (2019). 2018 대전의 사회지표 [2018 social indicators of Daejeon], *62..* Retrieved http://e-book.daejeon.go.kr/20190201_131547/

―――. (2000). The 38th Daejeon Statistical Yearbook. Retrieved from https://www.daejeon.go.kr/sta/StaStatistics PubList.do?category=149&menuSeq=185.

―――. (2010). The 48th Daejeon Statistical Yearbook.

―――. (2014). The 52th Daejeon Statistical Yearbook.

―――. (2018). The 56th Daejeon Statistical Yearbook.

―――. (2019). The 57th Daejeon Statistical Yearbook.

Gaffney, C., & Robertson, C. (2018). Smarter than smart: Rio de Janeiro's flawed emergence as a smart city. *Journal of Urban Technology, 25*(3), 47–64.

Glasmeier, A., & Christopherson, S. (2015). Thinking about smart cities. *Cambridge Journal of Regions, Economy and Society, 8*(1), 3–12.

Glasmeier, A., & Nebiolo, M. (2016). Thinking about smart cities: The travels of a policy idea that promises a great deal, but so far has delivered modest results. *Sustainability 8*(11), 1122. MDPI AG. Retrieved from http://dx.doi.org/10.3390/su8111122.

International Telecommunication Union. (2014, October). *Smart sustainable cities: An analysis of definitions.* Retrieved from https://www.itu.int › Documents › Approved_Deliverables › TR-Definitions.

Korea Trade-Investment Promotion Agency. (n.d.). Daedeok Innopolis. Retrieved from http://www. investkorea.org/daejeon_en/industry/industry01.do.

KOSIS. (2019). *Local Government Fiscal Independence in Korea.* Retrieved from http://kosis.kr/statHtml /statHtml.do?orgId=101&tblId=DT_1YL20921.

Kwon, H. (2018, Feburary 14). 데이터 혁명과 개인정보보호법은 친하게 지낼 수 있을까? [Can the data revolution and privacy laws be friendly?], Boannews, Retrieved from https://www.boannews.com.

McKinsey Global Institute. (2018). *Smart cities: Digital solutions for a more livable future.* Retrieved from https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/smart-cities-digital-solutions-for-a-more-livable-future.

Meijer, A., & Thaens, A. (2016). Urban technological innovation: Developing and testing a sociotechnical framework for studying smart city projects, *Urban Affairs Review,* 1 –25.

Ministry of Land, Infrastructure, and Transportation. (2019). 스마트시티 통합플랫폼 기반구축 [Construction of the integration platform for smart cities]. Sejong: Korean. Ministry of Land, Infrastructure, and Transportation.

———. (n.d.). *Cities.* Retrieved from http://www.molit.go.kr /english /USR/WPGE0201/ m_36854/DTL.jsp.

Nancy, T. (2018, June). *Three Emerging Technologies To Improve Emergency Management.* Retrieved from https://datasmart.ash.harvard.edu/news/article/three-emerging-technologies-improve-emergency-management.

Neumann, O., et al. (2020). Joining forces for public value creation? Exploring collaborative innovation in smart city initiatives. *Government Information Quarterly, 36*(4).

Zuzul, T. (2019). "Matter battles" : Cognitive representations, boundary objects, and the failure of collaboration in two smart cities. *Academy of Management Journal, 62*(3)*,* 739–764.