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# COMPARISON ANALYSIS OF SMART CITY PROJECTS – IMPLICATIONS FOR U-CITY –

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**Abstract.** Most of the world cities today have common socioeconomic urban problems resulted from rapid increase of population, such as enlargement and concentration of urban facilities, aging population, rising crime, and threats to urban safety. As the solution to these problems, smart city projects are performed in various parts of the world. This study selected a few countries well known for its successful performance in smart city projects: Korea, Japan, China, the United States, and several countries in Europe. The study compared and analyzed characteristics of the projects that had been promoted by selected countries. To be specific, thoroughly investigated are background, time, promotion system, and application area of each country's projects for the purpose of drawing out implications to be considered when launching the projects. As a result, it was confirmed that the projects had been typically enforced by the central government in East Asian countries, while the US had commissioned state governments, local governments, or private enterprises as the main actors of the programme. The most notable is the fact that some of the European countries have built a cooperative system between civil society, businesses, and local governments and this had led to successful consequences. It implies that the formation of open and innovational cooperation system for demand side, which results from the integration of the governments' strong impetus, technical skills of companies, and the support of citizens, is required. The study also concluded that smart city projects were usually applied to the development of new towns, but they also should be implemented to urban regeneration projects.

## INTRODUCTION

### Background

A variety of urban problems come up now as urban population rapidly increases, which results from urbanization mainly generated by a population drift away from rural areas to urban areas. To be specific, the remarkable growth of city population has triggered enlargement and concentration of urban facilities, aging population, rising crime, and threats to urban safety. Unfortunately, the trend of urbanization is expected to continue according to the report published by the United Nations (UN). The UN reported 'World Urbanization Project' based on census conducted in 233 countries, and the main statement of the report was that world population would rise approximately from 7.2 billion (in 2014) to 9.5 billion (in 2050) and most of the increment would concentrate in large cities. In fact, the proportion of urban population is predicted to reach about 66% by 2050, while that of rural population is forecasted to grow down to 33%. Therefore, some countries now actively deal with the problems by implementing smart city projects.

For example, in Korea, by applying high-tech information and communication technology, an information system has been set up and operated for management of facilities, disaster, safety, transportation, and environment in the cities. A primary (2009-2013) and secondary (2014-2018) 'Ubiquitous City (U-city) Comprehensive Plan' have been established and performed in order to construct a system for overall management, to promptly handle the emergency situations, to cut down management and operation expenses, and to invent new service industry.

In the same vein, not only Korea shows a great interest in smart city projects. China, showing most aggressive attitude to construct smart city, announced that more than 50 trillion won (40 billion in US dollar) will be invested in smart city projects.

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Moreover, the total number of smart city projects performed in the world has risen recently, although it is rather concentrated in several countries. Nikkei BP estimated that 608 projects have been reported until now and 84% of them were performed in Korea, Japan, China, the United States and the Europe.

**Purpose**

Smart city projects witnessed in various parts of the world are applied as effective method to cope with socioeconomic urban problems that all countries are sharing now and each country is inherently facing. Thus, this study intended to suggest valuable implications to be considered when launching the projects by comparing and analyzing the characteristics of the projects that had been promoted by leading countries. Concretely, in chapter 2, the study selected a few countries well known for its successful performance in smart city projects: Korea, Japan, China, the United States, and several countries in Europe. And it thoroughly investigated background, time, promotion, system, and application area of each country's projects. In chapter 3, implications were drawn out based on the research results suggested in chapter 2.

## PROJECT ENFORCEMENT SITUATION FOR EACH COUNTRY

### Korea

Smart city projects in Korea started in 2003 when new towns are actively constructed in capital area, such as Songdo in Incheon, Heungdoek in Yongin, Unjeong in Paju, and Pangyo in Seongnam. In 2006, the Ministry of Information and Communication established 'the Master Plan for Constructing and Invigorating U-city' which explains how the ministry would develop standard model of U-city services and legalize the projects. In the virtue of these efforts, the law on construction of U-city has been enacted since 2008, and a primary and a secondary 'U-city Comprehensive Plan' were published in 2009 and 2013, respectively.

The general policy-making on smart city is now handled by the Ministry of Land, Infrastructure, and Transport, the administrative works are by the Ministry of Security and Public Administration, and the specific policy-making in regard to energy and environment is by the Ministry of Trade, Industry, and Energy. The concept of U-city suggested first by the Ministry of Information and Communication and that of the one in operation now by the Ministry of Land, Infrastructure, and Transport are the same. Both ministries propose as the goals improving the quality of life in city, encouraging city competitiveness, procuring competitiveness of domestic businesses, and exporting the model of U-city to other countries by the way of utilizing information and communication technologies (ICT). The aspect that setting exporting relative techniques to other countries as a goal at first when the projects were launched is appraised as an advantage of Korea compared to other countries.

Now, 73 cities out of 250 cities in Korea are planning or implementing the smart city projects. Among those cities, almost 65% are estimated to promote the projects when constructing new towns. 55% of cities in capital area and 23% of cities in rural area are calculated to carry forward smart city projects.

In addition, the Korean government is now enforcing support project for U-services (TABLE I). The purpose of the project is to improve public services and to resolve national pending issues by guaranteeing that everyone can have access to any services whenever and wherever they want.

**TABLE I**
**CURRENT SITUATION OF SUPPORTING PROJECT FOR U-SERVICES**

| Year | Service Details |
|---|---|
| 2008<br>(22) | · RFID-based clearance of importing air cargo<br>· USN-based combined monitoring of weather and sea<br>· USN-based remote health monitoring<br>· U-Care on senior citizen who lives alone<br>· USN-based crime prevention and security services in children protection zone<br>· integrated control center for tunnels<br>· management of water treatment facilities<br>· unified management of city life wastes |
| 2009 | · RFID-based government goods management<br>· Demonstration project of developing waterfronts |

| | |
|---|---|
| (16) | · Urban facility management<br>· Management of carbon emissions<br>· Construction of ubi-Z<br>· Safety control of wooden cultural heritage<br>· Services on Eco Park<br>· Services on cultural space |
| 2010<br>(11) | · Clearance service on importing ocean freights<br>· Easy life service<br>· Monitoring on handicap parking<br>· Services to support and sustain traditional markets<br>· Fire control services<br>· Library services<br>· Senior community services |
| 2011<br>(13) | · 911 reporting services<br>· Provision of integrated information on disaster relief supplies<br>· Management of army recruit<br>· Realization of smart working environment<br>· E-book for people who live in farming and fishing villages<br>· Management of food wastes<br>· Prevention of damage caused by dangerous birds |
| 2012<br>(13) | · GPS-based information management for wastes<br>· Guidance of sightseeing<br>· Integrated management of steep slopes<br>· Maritime casualty safety management<br>· Management of integrated information on fish farms<br>· Smart town service for revitalization of old towns |
| 2013<br>(9) | · Monitoring atmospheric environment of industrial complex<br>· Control system for hazardous wild animals<br>· Cultivating container for crops<br>· Analysis system for managing growth and development of mushrooms<br>· Electronic system for transporting livestock excretions<br>· Emergent transfer system for people living on remote islands<br>· School meal services linked to local food system |
| 2014<br>(6) | · Navigation system for emergency rescue services<br>· System for appropriate treatment of livestock excretions<br>· Forecast and warning system for the collapse of steep slopes or reservoirs<br>· Monitoring of toxic substance spill in chemical complex<br>· Police support system with wearable cameras |

The government also starts to utilize IoT (Internet of the Things), and the business has got into stride since August 2015 when the government established ground plan for applying IoT to U-city. It is the end of the road that the country gains reputation of leading country making the best use of Iot in spite of stiff competition between countries.

**Japan**

Smart city had been barely remarked in Japan until 2010. However, in 2011, when Japan envisaged an energy crisis squarely because of massive earthquake in East Japan and Fukushima nuclear disaster, Smart Policy to secure energy infrastructure with the use of Smart Grid became government's major concern. The government anticipated that smart city would effectively rehabilitate the cities in northeast area destroyed by the earthquake and it would be useful way to cope with not only energy crisis but also other social issues such as super-aging, low birthrate, and disaster prevention.

In common with other countries, smart city projects in Japan are also promoted by major government agencies. The most representative governmental businesses are the plan for Eco-Friendly Future City, the plan for Smart Community, and the plan for ICT Smart Town.

1) The Plan for Eco-Friendly Future City

The plan for Eco-Friendly Future City was established in 2008, and it selected 13 different cities in order to reduce the amount of greenhouse gas emission to half until 2050. It is revised to cover 11 more pilot cities including Kitakyushu. The specific test projects for next generation energy and social systems promoted by the plan are organized in TABLE Ⅱ. In brief, all projects set targeted population and CO2 emission and utilize smart technologies such as Electric Vehicles (EV), Energy Management System (EMS), Intelligent Transport Systems (ITS), Photovoltaic (PV), Demand Reduction (DR), wind power, heat energy, biomass, and storage batteries.

**TABLE Ⅱ**

**TEST PROJECTS FOR NEXT GENERATION ENERGY AND SOCIAL SYSTEMS**

| Project | Targeted Population | Technology | Targeted $CO_2$ emission |
|---|---|---|---|
| Keihanna Eco City (Kyoto, Ohara and Nara prefectures) | 102,024 people | ·EMS<br>·Power DR<br>·EV | ·-20% $CO_2$ emission in households by 2030 (to 2005 levels)<br>·-40% $CO_2$ emission in transport 1,000 houses with PV |
| Kitakyushu Smart Community (Fukuoka prefecture) | 225 households | ·PV<br>·Wind power<br>·Heat energy<br>·Hydrogen<br>·EMS<br>·EV<br>·Data centre | ·-50% $CO_2$ emission in household, residential and transport by 2030<br>·10% of production = new energy Smart meters for 70 firms and 200 households |
| Toyota Low Carbon Society (Aichi prefecture) | 227 households | ·PV<br>·Biomass<br>·EMS<br>·EV & ITS | ·-20% $CO_2$ emission in households<br>·-40% $CO_2$ emission in transport 3,100 EV |
| Yokohama Smart City (Kanagawa prefecture) | 4,000 households | ·PV<br>·Storage batteries<br>·EMS<br>·EV | ·-30% $CO_2$ emission by 2025 (to 2004 levels)<br>·27,000 kW PV<br>·2,000 EV |

The most exemplary Eco-Friendly Future City is Kitakyushu. The city has the goal to become both environmentally friendly city

and people oriented city where vulnerable members of society get consideration. For this, it carries forward various businesses. To be specific, Kitakyushu started a demonstration experiment of Smart Grid Dynamic Pricing in 2012 and achieved 45.9% of energy savings through solar heat-based Building Energy Managements Systems (BEMS).

**The Plan for Smart Community**

'The Test Project for the Next Energy System', which integrates renewable energy into the former energy system for the purpose of efficient energy management, has been launched in 2009. Since then, cities such as Yokohama, Toyota, and Kitakyushu are selected as test bed in 2010 (FIGURE I), and 8 victim cities damaged by massive earthquake was added to the list of pilot cities for Smart Community in 2011. Now, the government looks forward to apply the evaluation results of precedent projects to these 8 cities.

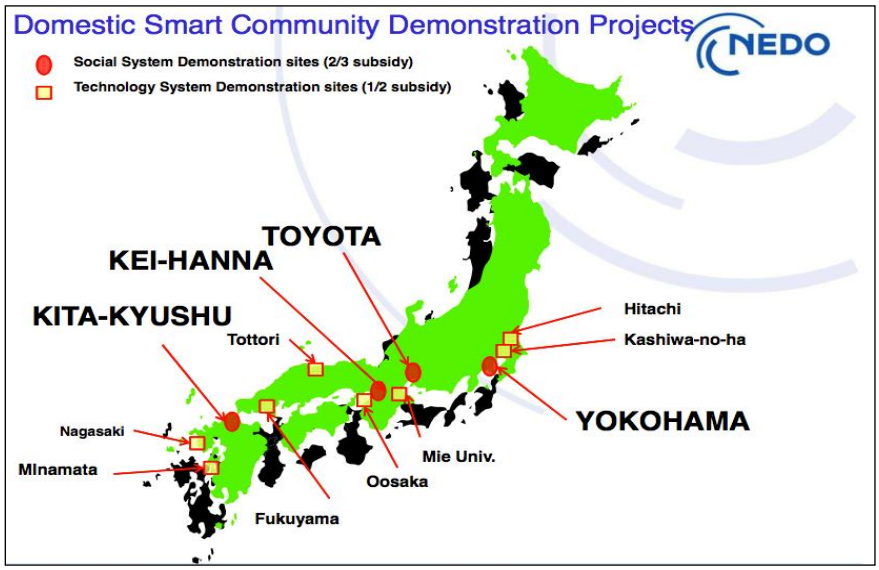


**Figure I.** Smart Community Projects in Japan

Yokohama formed a successful Smart City Model with the cooperation between citizens, firms, and the city government. And the city went on to construct social system which applies low carbon related technology to the fields of energy, building, and transportation. The final goal of the city is more than 60% (to 2004 levels) reduction of greenhouse gas emitted by a person until 2050.

**The Plan for ICT Smart Town**

The catastrophe of severe earthquake in 2011 has triggered the Japanese government to arrange 'the ICT Strategies for Revival and Regeneration of East Japan'. The same intent was continued to 2012 when the government suggested 'the Plan for ICT Smart Town', which aims to resolve urban problems, to secure urban safety, to accomplish economic revitalization, to create jobs, and to encourage national competitiveness.

**China**

After economic reform, China faces manifold problems due to rapid increase in urban population. This is because urbanization has been processed for such a short period of time. It is estimated that 1% of Chinese population, which equals to approximately 12 million people, moves from rural area to urban area every year, and this causes the shortage of the city's infrastructure.

Securing and saving the energy has become national tasks in priority since China have reached the second economic scale in the world. To maintain the growth of economy, China couldn't avoid fall in the degree of self-sufficiency in energy because of heavy industry centered growth strategy. Environmental pollution, especially in regard to smog and fine dust, also became a serious object of public concern. For these reasons, the Chinese government proactively imposed smart city projects and tried to encourage service industry and stimulate the industry

transformation. Furthermore, the government affected personal spending to increase, which would lead to more investment and finally to change in growth engine.

During the period of 12$^{th}$ five-year plan (2011-2015), the Chinese government was meant to construct 320 smart cities with a minimum investment of 300 billion yuan. The department responsible for all smart city policies, the Ministry of Housing and Urban-Rural Development of the People's Republic of China, announced 193 cities as test bed in 2013. The pilot cities received

a variety of support from the department during 3~5 years of developing period and now are screened for classification. It is expected that smart city projects will be expanded to small and medium-sized cities unlike precedent projects which targeted mostly on large cities.

For example, Tianjin Eco City, which receives attention as the new model of regional economic development for China, is the first smart city ratified by the government. The business was started when Chinese prime minister and Singaporean prime minister agreed to construct city with ecologically sustainable urban environment in the region a little away off the Tianjin. Tianjin Eco City follows the successful model of Special Economic Zones in Shenzhen and New Borough of Pudong in Shanghai and is well known for introducing IoT to form Wireless Sensor Network (WSN).

**Figure Ⅱ.** Site of Tianjin Eco city

**Figure Ⅲ.** Blueprint of Tianjin Eco city

**The United States**

Policies for smart city enforced in US are concentrated on Smart Grid and e-Health Care. In contrast to Asian countries where all smart city projects are mainly led by the central government, the federal government of the US only takes care of Smart Grid and e-Health Care while delegating the rest of power related to smart city to the state governments and private enterprises.

The reasons why the federal government shows a great interest in only two fields of smart city project are old electrical grid and high level of medical expenses in US. To begin with, electrical grid in US was constructed such a long time ago, so it became obsolete causing substantial power dissipation and lowering the quality of electricity. In fact, there was major blackout crisis covering the area of northeastern US and part of Canada in 2003.

The degree of electric loss is estimated to 7.4%, and the amount of economic loss due to power quality degradation is calculated approximately 150 billion dollar per year. Moreover, US is

known as the country where the ratio of medical care spending to consumption expenditure is the largest in the world. It is also predicted that the proportion of people over age 65 will be 20% by 2030, which will result in more household health expenditure.
Navigant Research has recently published the report of analyzing the competitiveness of companies specialized in smart city solutions, and according to the report, IBM and Cisco Systems are well appreciated.

**IBM's Smarter Cities™**

IBM introduced the initiative named 'Smarter Cities™' in 2008 in order to make the world smarter, and it is the first trial to use the concept of Smart City in the field of work. The Police Agency in New York requested IBM to construct integrated system for analyzing crime information and invested 11 million dollars to set up 'Real Time Crime Center (RTCC)'. Now, about 37 thousands of police officers use various databases related to crime, and crime patterns in real time can be visualized by analysis tools provided in the system. The introduction of RTCC resulted in rising rate of settling murder case and decrease in crime rate.

**Cisco Systems' Smart+ Connected Communities™**

In 2009, Cisco presented the smart city initiative called 'Smart+ Connected Communities™' which focuses on networking and intellectualization of urban infrastructures. The company defined it the initiative to support changes in the community from physically dispersed one to efficiently integrated one by the network. The core of the initiative is the technology of network building mediator that connects components of buildings intelligently. Cisco expands its use to home, workplace, hospital, and school. For example, Korean new town in Songdo is a case for the application.

**Europe**

In Europe, European Commission (EC) is in chief of smart city projects promoted on the level of European Union (EU), especially putting emphasis on energy and transportation, while specific businesses are promoted individually by a country or city. According to Nikkei BP, the number of smart city projects performed in Germany is 20, the United Kingdom is 13, France is 10, Denmark is 9, and Sweden is 8 since June 2013.
Barcelona Smart City in Spain is known as the most successful model of urban regeneration. Barcelona, which ranks second among Spanish cities regarding its size, was once flourished with textile industry, but it slowly decayed as new industrial complex was developed in Montjuic Hill in 1965. During the years of 1963~1990, more than 1,300 factories were relocated to other regions, and the city became a slum. To rehabilitate Barcelona, the plan named '22@Barcelona38' was set up. The city government started a project to transform the former industrial complex into knowledge-intensive high-tech one by agglomerating knowledge-based industries to the complex. As a result, Barcelona has grown to be the smartest city of Europe, and it is highly acclaimed for its cooperative system between industry, academy, and the government and efficient management of public data open for everyone.
Now, Barcelona is working on building a Smart City Campus at 22@ co-working space in Poble Nou. This is boosted by the investment and collaboration pledge from corporations Scheinder, CISCO, Agbar, and Abertis, with an estimated completion of summer of 2016. The campus will house corporations, innovators, universities, researchers, and entrepreneurs to create an ecosystem to lead in smart city solutions. With the city government leading the way in innovation, participation of private sector and investments occurs naturally.

**Figure Ⅳ.** Smart City Campus At The 22@ Co-Working Space

Another successful example in Europe is the project promoted by Deutsche Telekom in Germany. The company carried out more than 50 test projects on 6 different fields of smart city, such as transportation, education, culture, administration, medical service, and jobs. The project is now judged to be a great success, and critical success factor lies in active participation of diverse enterprises, open collaboration, and enthusiastic cooperation from local government and the residents.

## IMPLICATIONS FOR SMART CITY PROJECTS

Based on the results explained in chapter 2, several implications for smart city projects are deducted by comparing merits and demerits of selected countries.

### Open and Innovational Cooperation System between Citizens, Firms and Governments

In Korea, the government has taken the lead at promoting smart city projects by establishing U-city Comprehensive Plan. As the project develops to spreading stage, participation of firms and cooperation of citizens are highlighted. Korean projects have interesting point at aiming at first to improve domestic enterprises' competitive power and to export the model to other countries. Therefore, its focus is on development and accumulation of technology and know-how related to smart city solutions.

As for Japan, a variety of smart city policies are in operation, and most of the projects are mainly promoted by the government. The plan for Eco-Friendly Future City, the plan for Smart Community, and the plan for ICT Smart Town exemplify smart city projects performed in Japan.

China, meanwhile, shows the peculiarity that smart city projects were sporadically implemented by local governments in the past. However, after 2013, the central government has announced a new national smart city project and has set the plan to promote the project with the cooperation of different departments.

Not like other countries where the central government leads smart city initiatives, the federal government of US only concentrates on constructing Smart Grid and e-Health Care. It gives state or local government and private companies an authority to promote businesses in other fields of smart city projects.

In Europe, EC manages the policies on smart city that affect all and some of the countries in Europe, which especially focus on energy and transportation, and specific policies and businesses for smart city are enforced by each country and city. Smart city test projects targeted in Friedrichshafen and conducted by Deutsche Telekom were especially highly appraised for their successful results due to various enterprises' active participation in the projects, open collaboration, and enthusiastic cooperation from local government and residents.

While the government plays a role as a prime mover in East Asian countries, smart city projects in US are mostly promoted by state or local government as well as private enterprises. Several countries in Europe also delegate its authority on smart city projects to localities and companies. In Particular, Friedrichshafen Smart City Project in Germany is an excellent exemplification that gives us an implication to consider open and innovational cooperation system between citizens, firms, and governments.

### Service System for Demand Side

If the project is promoted by the governments, the project will proceed much more quickly. However, there is a weak point that ideas of citizens cannot be sufficiently reflected in the project. As we have seen before, most of the countries have the structure of government's taking lead of the smart city projects, and this increases the possibility of failing to notice demand side. In fact, smart city projects in Korea faced the problems of lacking the services that citizens require in real life, because most of them are designed by governments without considering citizens' needs. It is the common cause of the problems Korean smart city projects experienced that governments and firms hastily applied the latest technology and commodity available at that time to urban infrastructure rather than gave an effort to understand basic information on what were the issues the city encountered and which were the services citizens really asked for.

Thus, smart city projects should make use of the service system that is based on demand side. This fact can be proven again by looking into the example of Barcelona. The case shows that realization of smart city can be achieved not only when the newest and highest technology is utilized but when it meets citizens' real needs. When the project satisfies citizen's appetite fully, whether the technology costs a great deal or not and whether it is special or typical is not a matter. In other words, how well governments, firms, and citizens understand each other is the key to the sustainability of smart cities.

### Sustainable Smart City Paradigm

Korean legislation on U-city specifies the range of the services to administration, transportation, logistics, education, environment, management of facilities, health/medical/welfare, prevention of crime and disasters, employment, and culture/tourist/sports, while other countries, such as Japan, China, US, and the Europe, define smart city arbitrarily as eco-friendly and sustainable city which utilizes ICT techniques. This suggests that Korea should expand its service range to include the concept of 'smartening the energy' so that it can effectively respond to amalgamation movement between the field of energy and that of environment.

### Utilization of Smart City on Urban Regeneration

Most of smart city projects performed in Korea are greenfield

projects, which construct new town on the place where there was no city. Therefore, there is a great gap between new towns and old towns, and the gap hinders balanced city development in the country. Limiting the size of the land that smart city project can be processed to a certain scale by the law is partially responsible for the problem. This is different with several countries in Europe, such as Netherland and Spain, where smart city projects are promoted as brownfield projects by retaining the former urban infrastructure.

## CONCLUSION

Rapid increase in urban population has caused a wide range of socioeconomic problems such as aging and too much enlargement and concentration of urban facilities. As a solution to these problems, smart city projects are widely promoted in the world. By catching the trend, this study found a necessity to investigate background, start time, enforcement method, and application area of smart city projects implemented in several countries. Based on the analysis results, valuable implications to be considered when launching smart city projects were drawn out as follows.

First, open and innovational cooperation system is needed. It is for successful construction of service system that effectively reflects the needs of citizens. And this can be fulfilled when the governments' strong impetus, technical skills of companies, and the support of citizens are unified closely. In fact, the reason Friedrichshafen Smart City has produced good effects is because it encouraged an active participation of various actors in the field of business, government, and civil society. Korean smart city projects are still led only by governments, and it is the weakness that should be mended to take rank with other countries which already have considered localities, firms, citizens as project mover.

Second, Korea should take integrating viewpoint when promoting smart city projects, and in order to do that, inclusion of other fields that also have potential for application area of smart city should be done. The countries we have looked thoroughly in chapter 2 roughly define smart city as eco-friendly and sustainable city which utilizes ICT technologies. Contrastingly, Korea restricts the range of smart city's application area only to several fields, and this arouses concern that Korea will not effectively cope with the blending movement among different fields.

Lastly, Korea should utilize the concept of smart city not only on development of new cities but also on urban regeneration. It is easily speculated that smart city projects are only applicable to construction of new cities. However, smart city projects are also available when regenerating old towns, and it is much better way to maintain balance between the cities. In fact, Korea has promoted smart city projects along with development of new towns without doubt. By doing so, Korea has faced the problem of imbalance in developmental level between new cities and old cities. Since the law restricts smart city projects to be only applicable when the size of land developed is over a certain scale, greenfield projects that usually satisfy the condition are enforced and only new cities become equipped with the latest ICT technology. Not only that, considering that the successful projects performed in Europe share a common in promoting smart city projects as brownfield projects, utilization of smart city on urban regeneration is required.

This study suggested compelling explanation for each of leading countries' smart city and invaluable implications, but further study is needed because of data insufficient problem. After collecting and analyzing more ample data, proposal of more concrete direction for smart city projects will be possible.

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